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Analysis of Illinois' Hazardous Waste System:

Data Analysis and Application of a Waste Planning Model

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Illinois Department of Energy and Natural Resources

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Prepared for:

Illinois Hazardous Waste Research and Information Center
Under Contract HWR 87028

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Illinois Department of Energy and Natural Resources

ANALYSIS OF ILLINOIS' HAZARDOUS WASTE SYSTEM: DATA ANALYSIS AND APPLICATION OF A WASTE PLANNING MODEL

by

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Temple, Barker & Sloane, Inc. (TBS) would like to acknowledge the guidance and invaluable assistance of Gary Miller, Frank Brookfield and Lance Perry of the Illinois Hazardous Waste Research and Information Center. TBS also recognizes the ongoing effects on waste planning at the U.S. EPA, including Debora Martin in the Office of Solid Waste, who was the original project officer for the development of the Waste Planning Model. Throughout the development and applications of the model she has provided insight, assistance, and guidance.

EXECUTIVE SUMMARY

Since the passage of the Resource Conservation and Recovery Act (RCRA) by Congress in 1976, it has become increasingly evident that the problem of hazardous waste management is both larger and more complex than originally envisioned. Although the federal and state government standards that have been promulgated under RCRA addressed the problems of environmental protection, many wastes and disposal practices were still not sufficiently regulated to fully protect the environment and public health. In response to this situation, Congress passed the 1984 Hazardous and Solid Waste Amendments to RCRA.

These initiatives have increased the burden on planners and policymakers to deal with the issues surrounding the risks and costs of hazardous waste management. For instance, the demand for and siting of new treatment, storage, and disposal (TSD) facilities is a highly visible concern of the general populace. Additional pressures have been thrust upon the states by the 1986 Superfund Amendments and Reauthorization Act to demonstrate adequate hazardous waste treatment capacity in order to qualify for federal cleanup funds.

During 1985, TBS developed for the U.S. Environmental Protection Agency (US EPA) a planning methodology that assesses the costs and risks of hazardous waste generation and handling. The pilot application of the methodology was carried out in EPA Region I (New England), and a similar study was subsequently undertaken for EPA Region IV (southeastern U.S.). This methodology, in the form of the Waste Planning Model, has been applied to Illinois to provide a framework for analyzing the effects of hazardous waste management in the state.

A database of hazardous waste generation, handling, and flows has been developed in cooperation with the state. It is based on annual reports filed by regulated generators and TSDs. Data collected include generator site, generator Standard Industrial Classification (SIC) code, waste type, volume generated, treatment or disposal site, and handling method.

Also, the areas generating or receiving hazardous waste are characterized. Communities in close proximity to one another are "clustered" and assigned representative environmental profiles. These profiles describe the air, ground water, and surface water environments in each cluster and determine how dispersion of pollutants are calculated in the model when assessing health risks. Population profiles for each cluster area are also determined from 1980 census data.

Once the data and environmental characterizations have been developed, they are integrated into the Waste Planning Model, allowing the calculation of relative health risks. Releases of pollutants due to spills, volatilization, leaching, and residual emissions are estimated. These releases are translated into ambient concentrations to which people are exposed, and finally into individual and total population health effects. Cluster profiles and the various modules of the model are described in detail in Chapter 2.

Costs of handling are also calculated based on the volume of waste handled and the treatment or disposal method applied. Transportation costs are computed based on the number of miles and the volume transported. The number of transportation accidents resulting in releases is estimated in a similar manner.

Changes in risks and costs (impacts) are then simulated by interactively changing the inputs. Possible changes include waste volumes, waste types, TSD location, and TSD practices (handling methods). These changes can be made for all records or only those meeting certain criteria, such as a specific generator location, one RCRA waste type, or a particular SIC code. In addition, more in-depth analyses can easily be performed by changing the data files on waste composition, costs, or exposure environments. The scenarios analyzed for Illinois are discussed in Chapter 4.

The model is designed to be a planning and policy testing tool. It provides a framework to assess changes in cost and risk under various scenarios on an aggregate basis. By changing the flows and other data, the model can assess the relative impact of changes from the baseline present situation. This model is not meant to be used to assess absolute levels of risk. It should be used only to look at relative differences and changes in risk. The model is generally not recommended at this time for comparisons on a disaggregated level (e.g., it is less risky to site a landfill in cluster 1 than in cluster 4). The uncertainties built into the generic models used are too great to make these kinds of disaggregated comparisons valid in most instances. Rather, patterns across many clusters, or across clusters with certain characteristics, should be examined.

The results of the model are a function of the input data used. More accurate and more detailed data will give results that are less uncertain. The results are also a function of the generic release, fate, and transport algorithms used. These generic algorithms do not yield outputs that are highly site-specific. Nor do these algorithms account for catastrophic failures or non-compliant facilities.

In addition, the model does not take into account ecological effects, but only estimates effects on human health. In some cases (e.g., when human health risk is very low) ecological effects may have an increased importance for policy purposes.

The waste generation and handling data used for this project were supplied by the Illinois Hazardous Waste Research and Information Center (HWRIC), who obtained the 1984 annual report information from the Illinois Environmental Protection Agency (IEPA). The annual reports are submitted by regulated hazardous waste generators and treatment, storage, and disposal facilities (TSDs) in Illinois to IEPA, and undergo constant revisions to rectify discrepancies.

In order to estimate the risks associated with the management of the hazardous waste identified in Illinois, it is necessary to determine the composition (constituents and concentrations) of each RCRA waste stream. Although these waste streams can vary greatly in composition, we have used point estimates of the average composition of each waste stream. In almost all cases we have taken these point estimates from the average or typical characterizations used by EPA's Office of Solid Waste (OSW) for its Land Disposal Restrictions Benefits Analysis (ICF, 1985) and the OSW Risk-Cost Analysis Model (ICF, 1984). These profiles are acceptable for the policy and planning uses of the model on a broad level. It is important to note, however, that, for these and other reasons discussed elsewhere, the resulting model calculations should not be used as indicators of absolute risk.

The model evaluates 13 hazardous waste management strategies on a risk and cost basis. All other handling strategies are modeled as one of these 13. For each management strategy evaluated, the exposure routes are determined and appropriate release algorithms used. Release algorithms are based on work previously performed for EPA's Office of Solid Waste, Office of Policy Analysis, and Office of Air Quality Planning and Standards. Both continuous (e.g., stack emissions) and intermittent (e.g., spills) releases are estimated.

Once the release to the environment has been estimated, fate and transport algorithms are used to estimate the resulting ambient concentrations to which people may be exposed. The fate and transport algorithms are taken from previous EPA modeling work done for air (point and area sources), surface water, ground water, and ocean environments.

Fate and transport of pollutants will vary by environmental factors, such as ground water flow rate. Highly detailed, site-specific models are beyond the scope of the Waste Planning Model, so a limited number of "canonical," or model, environments were defined to cover the range of possible values in each medium. Each geographic area is assigned to one canonical environment for each medium. For example, the three surface water environments are small stream, medium stream, and large stream, based on the low flow rate. Every area will be categorized by one of these three choices.

After annual average ambient concentrations in air, surface water, and ground water have been determined for a cluster, it is then possible to estimate a plausible upper bound on the lifetime (70-year) health risks posed to exposed individuals. The health scores are used to estimate the probability of an adverse health effect given a particular level of exposure. Up to eight different health effects can be associated with exposure to a particular pollutant. Moreover, separate health scores may exist for air and water exposures.

The costs of on-site treatment are in 1985 dollars and are based on annualized capital and operating costs used in the EPA's RCRA Risk-Cost Model. Prices for off-site facilities are derived from: (1) price category quotes from a major Kentucky incinerator, (2) a price list from the CWM facility in Emelle, (3) Review of Activities of Major Firms in the Commercial Hazardous Waste Management Industry (Booz, Allen & Hamilton, 1982), and (4) Hazardous Waste Management in Massachusetts Environmental Impact Report (Massachusetts Department of Environmental Management, 1982).

The Waste Planning Model computes distances of all waste flows from the centers of geographic areas (based on latitude, longitude, and a factor to approximate the number of road miles). It will also compute approximate distances traveled in the state of Illinois for wastes going to or from other states. The model then estimates the number of accidents that will result in a release of hazardous waste, using a probability of 0.28/million truck miles on a composite highway trip (interstate, state, and urban roads).

In addition to the transportation risk, the model computes estimated transportation costs. Based on price quotes from transporters, the model uses an average transportation unit cost of $0.20/loaded ton-mile. Truck transport is assumed for all waste, based on a 1985 U.S. DOT profile that estimates more than 95 percent of hazardous waste is shipped by truck.

Hazardous waste generation in Illinois totaled 2.145 million metric tons in 1984, reported by 1826 regulated generators. This amount does not include generation by nonreporting generators, including many small quantity generators. Of this volume, almost 1.7 million metric tons was handled on-site by 235 of the generators. Eight companies in Illinois generated more than 50,000 metric tons of waste each. These eight generators accounted for 1.55 million metric tons of waste, or 72 percent of the total state generation, and are listed in Table 3 on page 21. Small quantity generators (SQGs) accounted for 3,341 metric tons of the total Illinois generation (0.2 percent).

The most common type of RCRA waste in Illinois in 1984 was D002, basic or corrosive wastes. Not quite 35 percent of Illinois generation was classified as D002. Waste combinations were the next most common type of generation, and three K wastes from specific sources were the other large waste types. A summary of Illinois generation by waste type is shown in Figure 4 and details are given in Appendix C.

Companies that fall under Standard Industrial Classification (SIC) 28, chemical and allied products, generated just over half of the hazardous waste in Illinois (see Figure 5). Electric, gas, and sanitary services (SIC 49) generated another 23 percent of the total. Just over 300,000 metric tons (14 percent) were shipped to 54 commercial facilities in Illinois, and 143,500 metric tons (7 percent) were exported out of the state. In addition, 132,000 metric tons of waste were generated out-of-state and imported into Illinois for handling.

The network of waste flows between geographic areas (clusters) can provide important information about where handling facilities are available relative to the generators who produce the wastes eligible for each handling method. The largest cluster-to-cluster flows for 1984 are shown in Figure 22, page 40. Note that these only include clusters with large shipments from one cluster to another. A cluster with a TSD who collects waste from several other clusters in smaller amounts, although the total volume handled may be large, will not show up on this network diagram.

The baseline population incidence risks (over 70 years) for each exposure route and health effect total 151 cases (18 cancer cases and 133 "other" noncancer cases). Please note that as explained in Section 2.6, the health risks presented here are conservative plausible upper-bound estimates. Moreover, these risks represent the incremental risk associated with hazardous waste activities; risk from background or other sources is not included. Finally, to offer some perspective, the population incidence numbers presented here (cases) occur across a population of approximately 11 million people potentially exposed in Illinois.

Almost all the air and ground water risk is associated with cancer health effects. On the other hand, almost all the surface water risk is associated with the "other" health effects category. These effects are primarily hypertension and FEP (a mild blood disorder) effects from lead exposures; the level of severity is not comparable to carcinogenic effects, for instance. It is also important to note that these "cases" are morbidity rather than mortality numbers (i.e., cases of disease rather than deaths).

A total of $598 million (1985 dollars) is associated with the handling of the two million metric tons of hazardous waste generated in Illinois. Transportation costs are estimated to be $1.9 million per year (figured at $0.2 per mile). The number of accidents associated with the transportation of this waste in which a release occurs is estimated to be 0.12 accidents per year.

In order to simulate the human health changes that would be associated with a ban on the injection of hazardous waste in Illinois, the Waste Planning Model was re-run switching all wastes reported as injected to on-site aqueous treatment. The on-site aqueous treatment is modelled as pH adjustment. Please note that we have characterized the injected waste based on actual test results of wastes injected in Illinois.

This scenario results in 1,003 metric tons per day being switched from injection to aqueous treatment and a slight (0.6 percent) decrease in total costs expended across the state. A slight increase in health risk results from the increased emissions to surface water. There is also no change in transportation risk (all injection was on-site; all aqueous treatment is assumed on-site).

Under the land ban scenarios examined, certain wastes were excluded from disposal on or in the land. Under the first land ban scenario examined, D001 through D009, F006 and K061 wastes were excluded from land disposal. These wastes were switched to a variety of handling methods based on the other methods currently used for the wastes in question. Specifically, 625 tons per day of wastes were shifted from landfill and surface impoundments to aqueous treatment and incineration. The human health impact of these switches is a significant increase in the risks from surface water exposure. A slight (0.8 percent) decrease in management costs also results. Transportation risk increases 8 percent to 0.13 accidents per year; transportation costs increase from $1.9 million to $2.0 million per year.

The second land ban scenario examined excluded two additional wastes from land disposal: K048 and K051. The risk changes are insignificant despite the switching of an additional 550 metric tons per day versus the Land Ban I. This is primarily due to the fact that the additional K wastes examined under this scenario contain metals which do not volatilize (chromium, lead). As a result, little risk is associated with these wastes in the baseline (and therefore there is little risk to be shifted when land disposal is banned). Costs, however, increase approximately 5 percent. Transportation costs and accidents are the same as under the Land Ban I scenario.

We also simulated the impact of a central metals recovery facility. The facility is modeled based on the description contained in Feasibility of a Central Recovery Facility for The Metal Finishing Industry in Cook County (Illinois ENR, November, 1986). The facility is assumed to recover 98 percent of the metals contained in various metal-containing sludges (F006, F007, F008, and F009); the unrecovered metals are discharged to surface water. We have located the hypothetical facility in Cluster IL04 (just west of Chicago) and assumed it accepts wastes from Clusters IL01 to IL09, IL19, and IL20 (see Figure 3 on page 20).

Using these assumptions, a total of only 26.2 metric tons are processed by the central recovery facility annually. This small shift results in no distinguishable change from the baseline human health risks and a slight increase in transportation accidents and cost (0.8 percent).

CHAPTER 1. INTRODUCTION AND BACKGROUND

Since the passage of the Resource Conservation and Recovery Act (RCRA) by Congress in 1976, it has become increasingly evident that the problem of hazardous waste management is both larger and more complex than originally envisioned. Although the federal and state government standards that have been promulgated under RCRA addressed the problems of environmental protection, many wastes and disposal practices were still not sufficiently regulated to fully protect the environment and public health. In response to this situation, Congress passed the 1984 Hazardous and Solid Waste Amendments to RCRA.

These initiatives have increased the burden on planners and policymakers to deal with the issues surrounding the risks and costs of hazardous waste management. For instance, the demand for and siting of new treatment, storage, and disposal (TSD) facilities is a highly visible concern of the general populace. Additional pressures have been thrust upon the states by the 1986 Superfund Amendments and Reauthorization Act to demonstrate adequate hazardous waste treatment capacity in order to qualify for federal cleanup funds.

During 1985, TBS developed for the U.S. Environmental Protection Agency a planning methodology that assesses the costs and risks of hazardous waste generation and handling. The pilot application of the methodology was carried out in EPA Region I (New England), and a similar study was subsequently undertaken for EPA Region IV (southeastern U.S.). This methodology, in the form of the Waste Planning Model, is now being applied to Illinois to provide a framework for analyzing the effects of hazardous waste management in the state.

Table 1 illustrates the basic outline of the model structure. First, a database of hazardous waste generation, handling, and flows is developed in cooperation with the state based on annual reports filed by regulated generators and TSDs. Data collected include generator site, generator Standard Industrial Classification (SIC) code, waste type, volume generated, treatment or disposal site, and handling method.

INPUTS	ASSUMPTIONS	OUTPUTS
Waste Generation --By waste type --By SIC Code --By location --Volume	Waste Constituents Treatment Effectiveness Environmental Releases	Costs Health Risks Transportation Risk
Waste Fate	Exposure Environments	Limited Capacity Information
TSD Description --Location --Capacity (if available)	Drinking Water Sources Health Impacts	

Table 1. Waste Planning Model Structure

The database, assuming the input data are accurate and complete, can then be used to describe waste generation and handling in the state along a number of different parameters. These data analyses alone are valuable tools for policymakers, providing an accurate picture of the existing hazardous waste situation in the state. Some interesting questions can be answered using the data, including:

- What are the largest generators in the state, and how do they handle their waste?
- Which types of industries are the largest generators of hazardous waste in the state?
- How much waste and what types are sent out of the state for handling? How much is imported into the state, what types of wastes are they, and how are they handled?
- Where are the major geographic areas of generation?
- Between which points do the largest waste movements occur?
- How much waste and what waste types are produced by electroplaters (SIC 3471)?

Chapter 3 presents several analyses of the hazardous waste generation and handling data collected from the state of Illinois.

Second, the areas generating or receiving hazardous waste are characterized. Communities in close proximity to one another are "clustered" and assigned representative environmental profiles. These profiles describe the air, ground water, and surface water environments in each clusterand will affect the nature of pollutant dispersion that will be calculated when assessing health risks. Population profiles for each cluster area are also determined from 1980 census data.

Once the data and environmental characterizations have been developed, they are integrated into the Waste Planning Model, allowing the calculation of relative health risks. Releases of pollutants due to spills, volatilization, leaching, and residual emissions are estimated. These releases are translated into ambient concentrations to which people are exposed, and finally into individual and total population health effects. Cluster profiles and the various modules of the model are described in detail in Chapter 2.

Costs of handling are also calculated based on the volume of waste handled and the treatment or disposal method applied. Transportation costs are computed based on the number of miles and the volume transported. The number of transportation accidents resulting in releases is estimated in a similar manner.

Changes in risks and costs (impacts) are then simulated by interactively changing the inputs. Possible changes include waste volumes, waste types, TSD location, and TSD practices (handling methods). These changes can be made for all records or only those meeting certain criteria, such as a specific generator location, one RCRA waste type, or a particular SIC code. In addition, more in-depth analyses can easily be performed by changing the data files on waste composition, costs, or exposure environments. The scenarios analyzed for Illinois are discussed in Chapter 4.

The model is designed to be a planning and policy testing tool. It provides a framework to assess changes in cost and risk under various scenarios on an aggregate basis. By changing the flows and other data, the model can assess the relative impact of changes from the baseline present situation. It allows analysis of questions such as:

- What are the effects (changes in cost, health risk, and transportation accidents) of moving wastes from land disposal to incineration?

- What would be the impact of source reduction activities undertaken by electroplaters?

- What are the preferred management strategies for solvents?

- What wastes, pollutants, and disposal methods account for the greatest portions of health risk under the current patterns of generation and handling?

This model is not meant to be used to assess absolute levels of risk. It should be used only to look at relative differences and changes in risk. The model is generally not recommended at this time for comparisons on a disaggregated level (e.g., it is less risky to site a landfill in cluster 1 than in cluster 4). The uncertainties built into the generic models used are too great to make these kinds of disaggregated comparisons valid in most instances. Rather, patterns across many clusters, or across clusters with certain characteristics, should be examined.

The results of the model are a function of the input data used. More accurate and more detailed data will give results that are less uncertain. The results are also a function of the generic release, fate, and transport algorithms used. These generic algorithms do not yield outputs that are highly site-specific. Nor do these algorithms account for catastrophic failures or non-compliant facilities.

In addition, the model does not take into account ecological effects, but only estimates effects on human health. In some cases (e.g., when human health risk is very low) ecological effects may have an increased importance for policy purposes.

CHAPTER 2. MODEL DESCRIPTION

The Waste Planning Model requires several pieces of information as input. Some, like the quantities of waste generated and handled by waste type, are specific to the area being studied. Others, such as exposure algorithms, are generic to the model. The data required by the model include:

- Quantity of waste generated and handled by waste type
- Waste stream constituents and pollutant characterization
- Exposure routes, environmental releases and fate and transport
- Clusters and environmental characterizations
- Exposed population estimates
- Health effects assessment
- Management cost assessment
- Transportation risks and cost estimates

The approach and assumptions in each of these are explained in the following sections. The waste generation data are analyzed in detail in Chapter 3. Figure 1 illustrates in a flow diagram how these pieces of information fit together in the model.

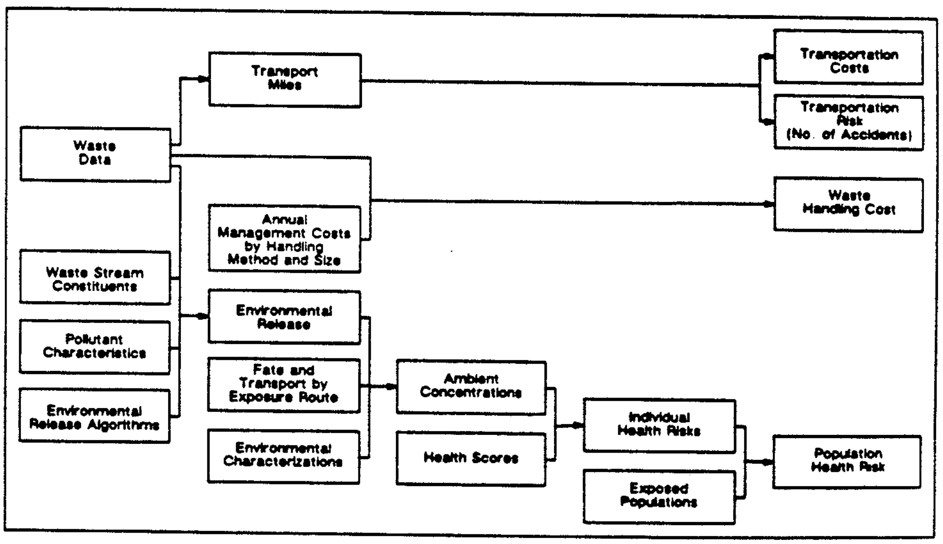

Figure 1. Flow Chart of Waste Planning Model

2.1 Waste Generation and Handling Data

The waste generation and handling data used for this project were supplied by the Illinois Hazardous Waste Research and Information Center (HWRIC), who obtained the 1984 annual report information from the Illinois Environmental Protection Agency (IEPA). The annual reports are submitted by regulated hazardous waste generators and treatment, storage, and disposal facilities (TSDFs) in Illinois to IEPA, and undergo constant revisions to rectify discrepancies. For example, a waste handler may discover that a reported waste is actually exempt, and will file a revised report. Therefore, the data presented here will not always agree with summaries published earlier or later by IEPA.

The data used from the annual reports include the following: generator name, generator location, generator SIC code, generator identification number, RCRA waste codes, quantity of waste handled on-site, quantity of waste handled off-site, and and off-site handler, method of handling. Please note that the handling method was not available for wastes shipped out of Illinois. For wastes that are generated and handled in Illinois, both the generator and the TSDF will report the waste, and for several reasons, such as measurement differences, may not always agree. This project used the waste volumes reported by the TSDF, assumed by HWRIC to be more accurate. TSDF-reported waste information is also used for wastes generated in other states, but handled in Illinois. Generator report data are used for Illinois generation that is shipped out of state for handling. A description of the Illinois reporting system is included in Appendix D.

Small quantity generators (SQGs) are those who generate less than 1,000 kg per month or who generate less than 1 kg per month of acutely hazardous (P) wastes. They are not required to submit annual reports. If the SQG generates and handles its wastes on-site, the wastes will not show up in these data. If the SQG ships its wastes out-of-state, the generation will again not show up in these data. However, the waste volumes will be reflected in these data if the SQG sends the wastes to an Illinois TSDF, because the TSDF will report the waste. We have no way of knowing what percentage of the small quantity generation volume is missing from our data.

It is important to note that the data include only those generators and TSDFs who report their wastes, and do not account for non-reporters. Non-reporters may include some small quantity generators, for the reasons described above, or generators or facilities who are circumventing the reporting requirements. Again, we do not know how much waste generation is not being reported.

2.2 Waste Stream and Pollutant Characterization

In order to estimate the risks associated with the management of the hazardous waste identified in Illinois, it is necessary to determine the composition (constituents and concentrations) of each RCRA waste stream. Although these waste streams can vary greatly in composition, we have used point estimates of the average composition of each waste stream. In almost all cases we have taken these point estimates from the average or typical characterizations used by EPA's Office of Solid Waste (OSW) for its Land Disposal Restrictions Benefits Analysis (ICF, 1985) and the OSW Risk-Cost Analysis Model (ICF, 1984). These profiles are acceptable for the policy and planning uses of the model on a broad level. It is important to note, however, that, for these and other reasons discussed elsewhere, the resulting model calculations should not be used as indicators of absolute risk.

Many generators report a mixture of RCRA waste codes associated with each volume. For example, a generator may report 1,000 kg of D001/D002/F003. It is not clear how much of the total volume belongs with each RCRA waste code. For the data analyses, we have defined these as "combination wastes." For use in the Waste Planning Model, waste constituent information is needed, so it was necessary to split the volumes between the different waste codes. For lack of better information, the volume was split equally between each waste code reported.

A constituent profile (including concentrations) has been estimated for each of the RCRA waste streams generated or handled in Illinois. In general, the composition estimates for characteristic wastes (D001, D002, and D003) are the most uncertain. The EP toxicity wastes (D004-D017) and the F wastes (from nonspecific sources) are slightly more certain. K wastes (from specific sources) are better still. P and U wastes (discarded and off-spec chemicals), although still not exact for every waste stream, are the most accurate. Appendix A lists the constituents and concentrations assumed for the least certain (D, F, and K) wastes. In the case of four wastes handled by underground injection, HWRIC supplied monitoring information, so actual waste profiles were used (see Appendix A).

In addition to constituent and concentration information, other parameters are characterized for each waste stream. These include:

- Heating value of waste stream (KJ/Kg)

- Fraction of each constituent that is dissolved
- Mass fraction of waste stream that is nonwater
- Mass fraction of waste stream that is suspended
- Mass fraction of waste stream that is ash

Where available, all data have been taken from the OSW Risk-Cost Analysis Model. In the case of P and U wastes that were not included in that source, 10 percent concentrations for the constituents of concern were assumed.

Importantly, all critical assumptions about waste streams, including the constituent and concentration data, can easily be altered in the Waste Planning Model as better information becomes available, such as was done here with the four injected waste streams. The model could also be amended to handle distributional information on waste stream characteristics or different characteristics by waste stream and generator SIC code. The data currently used can be accessed from the data files in the model.

Some information specific to each chemical constituent is also required for the release algorithms. From TBS research and the OSW Risk-Cost Analysis Model, the following data have been included for each pollutant:

- Vapor pressure (mm Hg at 25°C)
- Diffusivity (cm^2/sec) in air and water
- Solubility (mg/l at 25°C)
- Molecular weight (g/g-mole)
- Biodegradation rate (per day)
- Health risks (dose-response probabilities) and thresholds (ug/m^3 or ug/l)

For many pollutants, data on health effects are incomplete and can be added when available.

2.3 Exposure Routes, Environmental Releases and Fate and Transport

The model evaluates 13 hazardous waste management strategies on a risk and cost basis. All other handling strategies are modeled as one of these 13. For each management strategy evaluated, the exposure routes are determined (see Table 2) and appropriate release algorithms used.

Exposure routes and release algorithms are based on work previously performed for EPA's Office of Solid Waste, Office of Policy Analysis, and Office of Air Quality Planning and Standards. Both continuous (e.g., stack emissions) and intermittent (e.g., spills) releases are estimated. All treatment technologies are assumed to dispose of final residuals (e.g., incinerator ash) in a landfill in the same cluster as the TSD.

In some cases, the release models do not predict significant failures of RCRA landfills and surface impoundments until 75 to 100 years from the beginning of operation. For relative comparisons for planning and policy purposes, it was felt that the time delay would not be appropriate. In addition, there is currently no acceptable methodology for discounting risks at EPA. For these reasons, all releases are compared as if they occurred in a similar time period.

Once the release to the environment has been estimated, fate and transport algorithms are used to estimate the resulting ambient concentrations to which people may be exposed. The fate and transport algorithms are taken from previous EPA modeling work done for air (point and area sources), surface water, ground water, and ocean environments. Note that these models do not account for ground water infiltration into surface water. The models have been run for a unit input for each of the representative environments and are scaled linearly based on actual waste inputs; results are used in relating releases to ambient concentrations in the Waste Planning Model.

Fate and transport of pollutants will vary by environmental factors, such as ground water flow rate. Highly detailed, site-specific models are beyond the scope of the Waste Planning Model, so a limited number of "canonical," or model, environments were defined to cover the range of possible values in each medium. Each cluster is assigned to one canonical environment for each medium. For example, the three surface water environments are small stream, medium stream, and large stream, based on the low flow rate. Every

Table 2. Exposure Routes by Treatment Technology

MANAGEMENT METHOD		AIR	SURFACE WATER	GROUND WATER	OCEAN/FISH
Storage	Drums and Tank Storage	o Spill volatilization o Fugitive emissions from transfers		o Spills	
	Waste Pile	o Volatilization o Wind-blown particulates	o Spills from leachate collection system o Sediment run-off	o Leachate	
	Surface Impoundment	o Volatilization	o Overtopping	o Leachate	
Disposal	Underground Injection	o Well head failure	o Well head failure	o Well head failure o Casing failure o Formation failure	
	Landfill	o Volatilization from covered waste		o Leachate	
	Ocean Disposal				o Waste releases
Thermal Treatment	Liquid Injection Incineration	o Residual organics and metals	o Scrubber discharge	o Leachate from residue	
	Rotary Kiln Incineration	o Residual organics and metals	o Scrubber discharge	o Leachate from residue	
	Ocean Incineration	o Residual organics and metals			o Dumping of residues and scrubber discharge
Chemical Treatment	pH Adjustment/ Coagulation		o Effluent discharge	o Leachate from effluent	
	Distillation/ Solvent Recovery	o Volatilization from spill of equipment failure o Venting of safety relief valve/vent		o Leachate from still bottoms	
	Stabilization/ Fixation	o Volatilization from spill or failure o Fugitive emissions during mixing		o Vessel failure o Spills o Disposal leachate	
Biological Treatment	Activated Sludge	o Aeration basis volatilization o Equalization basin volatilization	o Effluent discharge		

cluster will be categorized by one of these three choices. The canonical environments and fate and transport models used are discussed more thoroughly in the next section.

2.4 Clusters and Environmental Characterizations

Clusters are created based on location of generators and TSDs. They have a radius of 19 kilometers and are centered near large generation or handling volumes where appropriate. Facilities are clustered to take into account coincident human exposures to releases from multiple nearby facilities. The model treats all sources as being located in the center of a cluster; the combined effects of releases from all sources within a cluster are then evaluated. Clustering also eases computations of exposures and flows.

Clusters are characterized by representative environmental choices. These representative, or canonical, environments have been developed based on the key parameters used in the release, and fate and transport models. The populations are determined, along with the percentages of the population that drink surface and ground water, for each cluster.

The EPA set of models and environmental data contained in GEMS (Graphical Exposure Modeling System) are used for several of the models and data requirements. The fate and transport of air-borne contaminants are based on results from the ISC (Industrial Source Complex) model in GEMS, which uses a gaussian plume modeling approach. Only one air environment is used for the fate and transport modeling (see Appendix B); mixing height is the driving environmental parameter in our results and varies little over the state. Conservative values have been assumed for facility operating characteristics in the fate and transport modeling. In addition, wind speeds for the nearest Star (weather) station have been accessed from the GEMS database and used in some air release calculations describing volatilization. Note that the incineration model does not account for formation of PICs (products of incomplete combustion).

The fate and transport of surface water pollutants is taken from results of EXAMS (Exposure Analysis Modeling System), also a part of the GEMS system. Three surface water environments are used--small, medium, and large coldwater streams (see Appendix B). The drinking water source is assumed to be 7-14 kilometers downstream from the point of pollutant discharge, and a drinking water treatment/removal efficiency of 50 to 75 percent is used in the Waste Planning Model. Eight types of pollutants (based on chemical structure and solubility) are modeled for each of these streams--five organics and three inorganics. One of the three surface water environments has been assigned to each cluster using The 7-Day 10-Year Low Flows of Illinois Streams (Singh, 1973) and assuming the drinking water from surface water sources is most likely to come from larger streams in the cluster. Drinking water from Lake Michigan is assumed for this analysis to be unaffected by hazardous waste constituents.

Ground water transport is based on results from the Liner Location Risk and Cost Analysis Model (Sobotka, 1985). Three categories of pollutant mobility have been modeled in each of nine saturated zone (aquifer) environments (see Appendix B), with no treatment assumed for drinking water taken from ground water. The Liner Location Model assumes no attenuation in the unsaturated zone. Ground water environments are assigned using the methodology described in Appendix B based on linear velocity of the ground water. The drinking water well is assumed to be 600 meters downgradient from the source.

2.5 Exposed Population Estimates

The populations for each cluster are broken down into four concentric rings (1.05, 4.5, 10.5, and 19 km in radius from the cluster center) and eight directional sectors to correspond to the results from the air modeling. These populations are accessed from GEMS, which uses 1980 census tract data. Proportions of the populations drinking surface and ground water are taken from drinking water source data obtained from the Illinois Water Survey. All people in the cluster are conservatively assumed to obtain their drinking water from the potentially contaminated sources (surface and ground water), except where the source is Lake Michigan, which is assumed for these purposes unaffected. The surface water model is for streams only; a dilution factor for a downstream lake can be estimated, but IHWRIC research indicates that Lake Michigan is a source for the area streams.

Populations for each ring in each cluster are given in Appendix B. The percentage breakdown of men, women, and children (used for estimating health effects from lead) are also given in Appendix B.

2.6 Health Effects Assessment

After annual average ambient concentrations in air, surface water, and ground water have been determined for a cluster, it is then possible to estimate a plausible upper bound on the lifetime (70-year) health risks posed to exposed individuals. This is done using a linear dose-response model with a threshold. The threshold, below which there is no effect, may be zero (such as for all cancer effects) or greater than zero (see Figure 2). Ambient concentrations are related to uptakes with the following assumptions: (1) a person drinks 2 liters of water per day, (2) a person breathes 20 cubic meters of air each day, (3) a person weighs 70 kilograms, and (4) absorption is equal to 100 percent of exposure. All health risk scores assume chronic exposure for a 70-year lifetime.

Figure 2. Health Score Models

The model assumes the data describing volumes, handling methods, and types of wastes are representative of hazardous waste activity every year in each cluster. The model also compares all releases as if they occurred in a similar time period.

The health scores are used to estimate the probability of an adverse health effect given a particular level of exposure. Up to eight different health effects can be associated with exposure to a particular pollutant. Moreover, separate health scores may exist for air and water exposures. The health effects evaluated are:

- Carcinogenicity

- Noncarcinogenic effects

  --Mutagenicity (chromosomal effects)

  --Teratogenicity (fetal effects)

  --Reproductive effects

  --Renal toxicity

  --Neuro-behavioral effects

  --Hepatic (liver) effects

  --Other effects (includes respiratory, hematologic, cardiac, skin, and adrenal effects)

The carcinogenic effects scores are primarily developed by the Cancer Assessment Group (CAG) at EPA; the noncarcinogenic effects scores and a few of the cancer scores are from toxicologists in the Regulatory Integration Division in the EPA Office of Policy Analysis and have not yet been peer reviewed.

For each health effect and pollutant, the unit health risk multiplied by the ambient exposure can be interpreted as the plausible upper bound probability that an individual will suffer an adverse effect (individual risk). This probability multiplied by the exposed population will give a plausible upper bound on the number of adverse health cases for the population (population risk).

Linear dose-response unit health risks have been developed by the U.S. EPA by extrapolating from animal test data to humans and from the experimental high dose-response relationships to the lower end of the curve. These curves also incorporate appropriate uncertainty factors in these extrapolations. The thresholds are based on the Acceptable Daily Intake (ADI) as determined by EPA or on experimentally determined levels of no or lowest observed effect. Actual health risks can reasonably be assumed to be no more than those estimated with this methodology (plausible upper bound).

Currently, health scores for 32 pollutants are included in the Waste Planning Model. These pollutants account for slightly over 14 percent of the nonwater volume waste in Illinois, based on the waste composition estimates in the model. The pollutants scored are:

Acrylonitrile	Dichloropropane
Aldrin	Diethylhexylphthalate
Arsenic	Ethylene Dibromide
Benzene	Heptachlor
Benz-(a)-anthracene	Lindane
Benz-(a)-pyrene	Mercury
Bromoform	Nickel
Butanol	Perchloroethylene
Cadmium	PCBs
Carbon Tetrachloride	Selenium
Chlordane	Toluene
Chloroform	Toxaphene
Chromium IV	Trichloroethane
Dichlorobenzene	Trichloroethylene
Dichloroethane	Vinyl Chloride
Dichloromethane	Xylene

The health scores are thresholds for these pollutants for each health effect are listed in Appendix A. Pollutants missing health scores are also listed in Appendix A.

Health effects resulting from lead exposures are determined differently, however. EPA has done an extensive amount of research on effects of lead exposures and has developed a somewhat more sophisticated model. First, the total uptake of lead is determined, including all exposure routes and background lead exposures. Then blood lead levels are estimated for men, women, and children. The resulting health effects are then calculated from blood lead levels based on a nonlinear dose-response relationship, and allocated back to each exposure route. The following health effects are evaluated for lead:

- Carcinogenicity
- Teratogenicity
- Reproductive effects
- Renal effects
- Neuro-behavioral effects
- Other effects

  --FEP (free erythrocyte protoporphyrin) and anemia (blood effects)

  --Hypertension (cardiovascular effects)

2.7 Management Cost Assessment

The costs of on-site treatment are based on annualized capital and operating costs used in the OSW RCRA Risk-Cost Model. Capital costs used here do not include interest during construction and working capital costs. All costs have been converted to 1985 dollars by escalating by the appropriate inflation factor. Capital costs are annualized by discounting all costs (including any closure costs) at a 10 percent real discount rate. Annual costs for small and large facilities differ depending on the annual operating volume of the model facilities to account for economies of scale. These costs are expressed in cost/ton or cost/gallon (see Appendix A).

Prices for off-site facilities are derived from: (1) price category quotes from a major Kentucky incinerator, (2) a price list from the CWM facility in Emelle, (3) Review of Activities of Major Firms in the Commercial Hazardous Waste Management Industry (Booz, Allen & Hamilton, 1982), and (4) Hazardous Waste Management in Massachusetts Environmental Impact Report (Massachusetts Department of Environmental Management, 1982). Prices have been checked against costs computed for large on-site facilities and adjustments made so that the two were comparable. All prices have been escalated to 1985 dollars. A summary of the prices and costs used in the model is included in Appendix A.

2.8 Transportation Risk and Cost Estimates

The Waste Planning Model computes distances of all waste flows from the centers of the clusters (based on latitude, longitude, and a factor to approximate the number of road miles). It will also compute approximate distances traveled in the state of Illinois for wastes going to or from other states. The model then estimates the number of accidents that will result in a release of hazardous waste, using a probability of 0.28/million truck miles on a composite highway trip (interstate, state, and urban roads).

In addition to the transportation risk, the model computes estimated transportation costs. It uses the cluster-to-cluster distances (as calculated for the transportation risk) and volume of waste transported. Based on price quotes from transporters, the model uses an average transportation unit cost of $0.20/loaded ton-mile. Truck transport is assumed for all waste, based on a 1985 U.S. DOT profile that estimates more than 95 percent of hazardous waste is shipped by truck.

2.9 Model Limitations

The Waste Planning Model is designed to be a policy and planning tool; the model will not yield definitive answers to hazardous waste problems. It can be used to estimate relative risks between options on an aggregate basis, but it does not give accurate estimates of absolute levels of risk. Several levels of assumptions have to be made in order to implement the Waste Planning Model, and a user should understand these before attempting to interpret the results.

Obviously, the model depends on the accuracy and completeness of the input data. The model cannot account for non-reported (including wastes from many small quantity generators) or misspecified wastes. It is important to remember that the model evaluates the incremental risk due to pollutant exposures from hazardous waste generation and handling; risk from background or other sources is not evaluated. This may be most important for health effects with a threshold; although the hazardous waste exposure alone may not exceed the threshold, total exposure from all sources may.

The model is less accurate when less detail is provided in the input data (e.g., broad treatment classifications, such as tank treatment, instead of specific handling practice, such as pH adjustment/coagulation). In this situation, the model assumes a handling method that falls into the broad category. In addition, the model can currently evaluate only 13 different types of handling technologies (the most common methods are those modeled); all management methods are modeled as one of these 13, which are listed in Table 2. Some inaccuracies are also introduced by using only these somewhat generic categories. In addition, the model currently uses cost data that is somewhat dated, computed for these broad management strategies, and not specific to Illinois.

The Waste Planning Model only estimates risk to human health; ecological effects are not evaluated. The model will output resultant concentrations that can be checked against existing criteria, but makes no attempt to quantify environmental effects. These effects may be of overriding consideration when human health risks are very small.

The model assumes RCRA-compliant facilities; releases due to improper management of wastes are not modeled. In addition, low probability, high consequence events such as catastrophic failure are not included in the model.

The biggest areas of uncertainty in the Waste Planning Model are the waste composition estimates and the release and fate and transport algorithms. In order to perform risk calculations, the RCRA waste stream descriptions must be translated into a quantitative estimate of pollutants and concentrations. At present, the model uses point estimates for each waste stream (see Section 2.2), which can lead to substantial error if the actual waste is significantly different than the estimated composition. As noted earlier, waste stream compositions can be amended as better information becomes available, such as was done here with some large volume injected wastes, or specified as a distribution of waste compositions.

Release estimates are partly a function of the physical design of the management facility. The model assumes one design and one or two standard sizes for each management method. A management configuration that is substantially different can also introduce error in the release estimates. The configurations used in the model are described in detail in the Regional Hazardous Waste Pilot Project Phase I Briefing (note: some changes have been made in the model since publication of this document).

The choice and application of the fate and transport models used in the Waste Planning Model may also introduce error. The model environments chosen represent a range of values; to the extent that the actual environment falls in between the values chosen, the model will predict the resulting pollutant concentrations less accurately. The fate and transport algorithms themselves may introduce uncertainty of up to several orders of magnitude.

Due to the various limitations and possible sources of error, the Waste Planning Model is designed to be used at an aggregate level, for purposes of planning and policy. At a statewide level, any inaccuracies tend to cancel out and general trends can be discerned. The model should not, however, be used at a local level to address issues such as facility siting. It is important that a user understand and account for the uncertainties in the model.

CHAPTER 3. ILLINOIS HAZARDOUS WASTE DATA

The data analyzed for Illinois and used in the Waste Planning Model are from 1984 generator and TSD annual reports from regulated facilities in Illinois. They include wastes imported into and wastes exported out of the state. Where both the generator and TSD are located in Illinois, the amount reported by the TSD, assumed by HWRIC to be more accurate, was used. All volumes have been converted to kilograms from gallons based on reported densities for ease in manipulation. When multiple waste codes are reported, the waste is treated here as a "waste combination." For risk purposes in the Waste Planning Model, the quantity was split evenly among all wastes reported.

The data used in this report were obtained from the Illinois Hazardous Waste Research and Information Center in September 1986. Illinois EPA has been constantly updating and correcting data; therefore, the summaries presented here may not agree precisely with those published by IEPA, (IEPA used some earlier and some later versions of the data set in their reports). Where we have become aware of improvements more recent than our data, we have incorporated them.

3.1 Clusters

The generation and handling locations in Illinois, located in 322 cities, have been assigned to 75 clusters in the state. These clusters are shown in Figure 3. The total 1980 population in these 75 clusters (total exposed population from hazardous waste activities) is 11.3 million people. Clusters of 19 kilometer radius are assigned based on proximity of towns. The cities in each cluster are listed in Appendix B. In addition, the representative environments assigned for each cluster are shown in Appendix B, along with the populations in each distance ring, the percentage drinking surface and ground water, and the latitude and longitude for the center of each cluster. These cluster definitions have been used for all map graphics in this document.

3.2 Generation

Hazardous waste generation in Illinois totaled 2.145 million metric tons in 1984, reported by 1826 regulated generators. This amount does not include generation

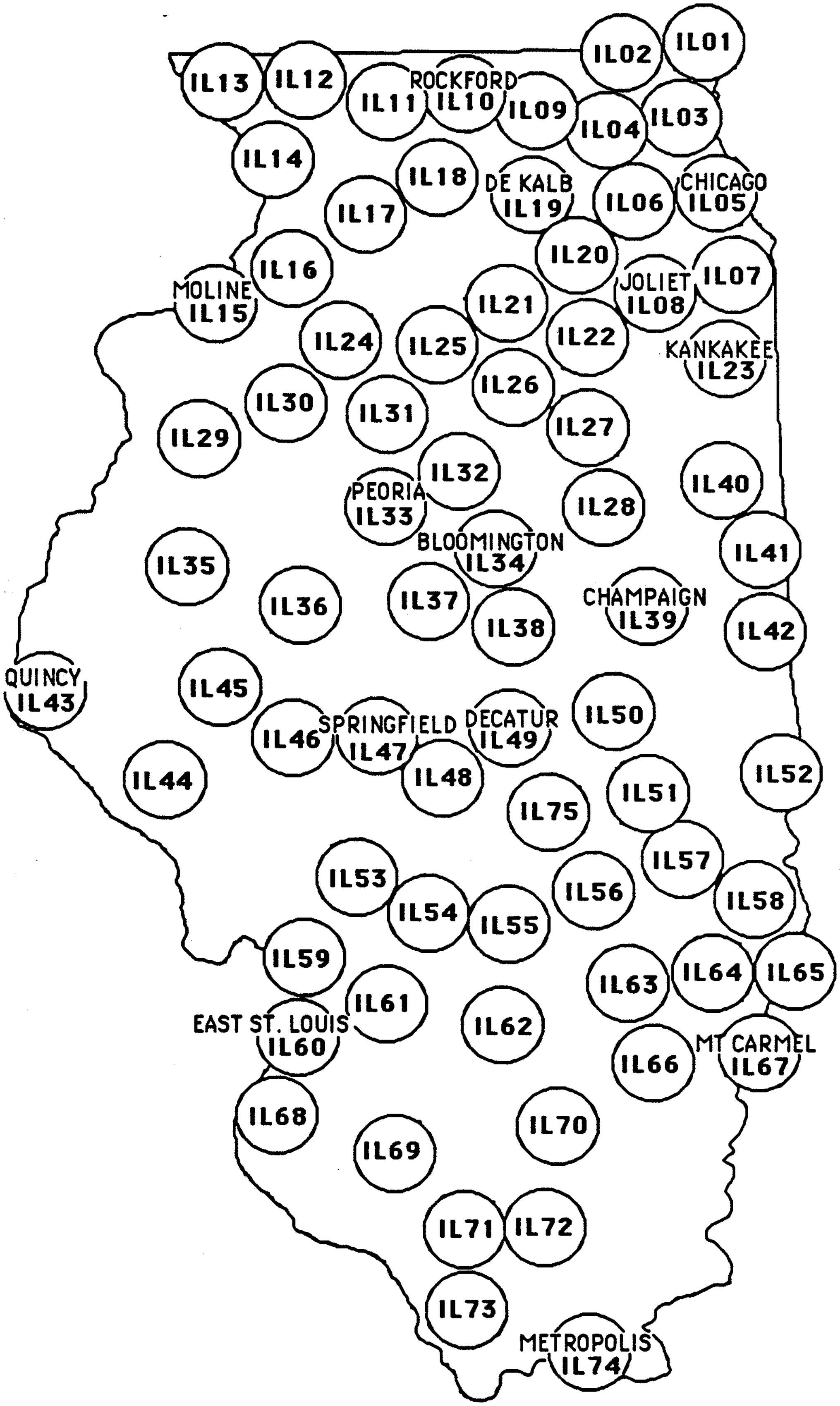

Figure 3. Illinois Clusters

Company	City	Cluster	SIC	Metric Tons Handled On Site	Metric Tons Shipped Off Site	Total Generation (metric tons)
Allied Chemical Corp.	Metropolis	IL74	2819	530,024	5	530,029
Velsicol	Marshall	IL52	2879	277,959	0	277,959
Cabot Corp.	Tuscola	IL50	2819	269,204	0	269,204
Amoco Petroleum Additives	Wood River	IL59	2911	154,545	0	154,545
Olin Corp.	East Alton	IL59	3341	98,081	7,354	105,435
Nutrasweet	Park Forest South	IL07	4950	0	84,419	84,419
CID #1	Calumet City	IL07	4953	53,682	15,862	69,544
Allied Chemical Corp.	Danville	IL42	4953	62,293	0.2	62,293

Table 3. Generators over 50,000 Metric Tons per Year

by nonreporting generators, including many small quantity generators. Of this volume, almost 1.7 million metric tons was handled on-site by 235 of the generators. Eight companies in Illinois generated more than 50,000 metric tons of waste each. These eight generators accounted for 1.55 million metric tons of waste, or 72 percent of the total state generation, and are listed in Table 3.

Small quantity generators (SQGs) accounted for 3,341 metric tons of the total Illinois generation (0.2 percent). This waste came from 883 reporting small quantity generators, which are defined as those generating a total volume of less than 1,000 kg/month (12 metric tons/year) or less than 1 kg/month of acutely hazardous (P) wastes was used here. Small quantity generators were not required to submit annual reports, although some do, so these data do not include many SQGs who treat or dispose on-site (the TSD will report wastes from those who ship off-site).

The most common type of RCRA waste in Illinois in 1984 was D002, basic or corrosive wastes. Not quite 35 percent of Illinois generation was classified as D002. Waste combinations were the next most common type of generation, and three K wastes from specific sources were the other large waste types. A summary of Illinois generation by waste type is shown in Figure 4 and details are given in Appendix C.

Companies that fall under Standard Industrial Classification (SIC) 28, chemical and allied products, generated just over half of the hazardous waste in Illinois (see Figure 5). Electric, gas, and sanitary services (SIC 49) generated another 23 percent of the total. A breakdown of

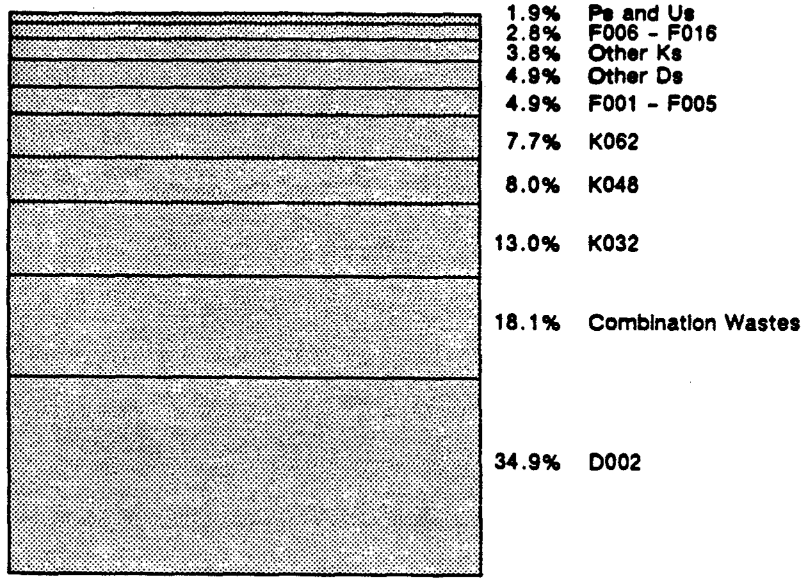

Figure 4. Generation by Waste Type

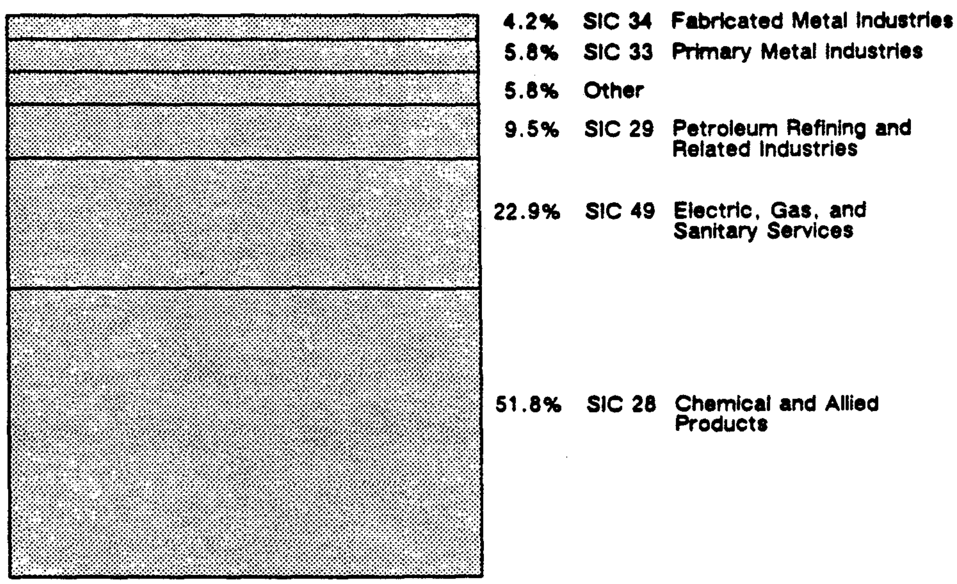

Figure 5. Generation by Two-Digit SIC Code

1984 Illinois generation by each two-digit SIC code is given in Appendix C.

Specifically, companies that fall into four-digit SIC code 2819 (industrial inorganic chemicals) accounted for 37 percent of total Illinois generation, and companies in

SIC 2879 (pesticides and agricultural chemicals) made up another 13 percent. In addition, 340 companies classified as SIC 4953 (refuse systems) generated 15 percent of Illinois' hazardous waste (the largest volumes coming from commercial and on-site TSDs). The largest generator classifications at the four-digit SIC code level are shown in Figure 6.

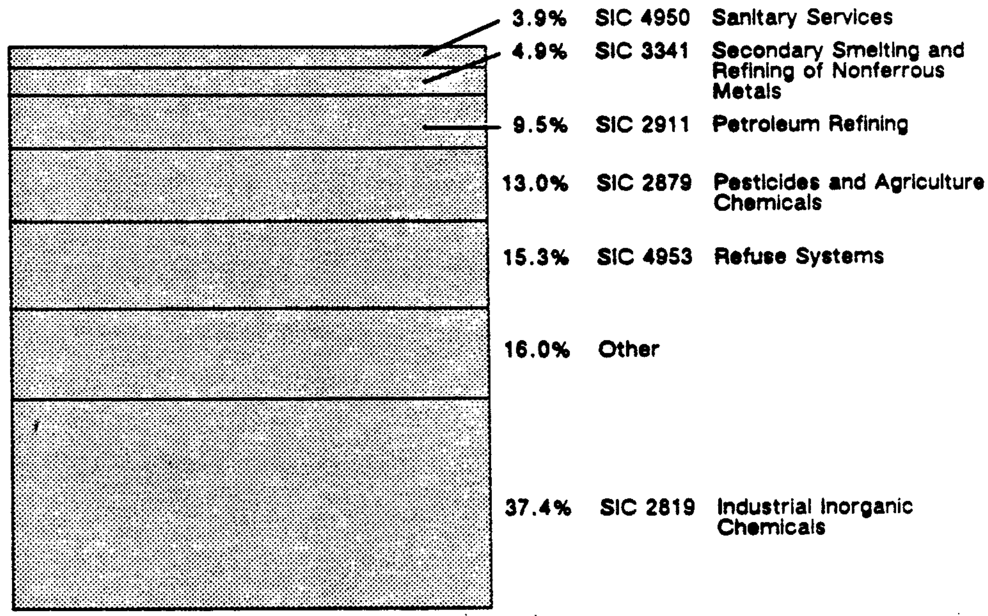

Figure 6. Generation by Four-Digit SIC Code

Generation in 1984 was concentrated in six clusters scattered around the state. In general, these major centers of generation correspond to the generators listed in Table 3. The relative size of generation in each cluster is shown in Figure 7 on the next page. It is interesting to note that the major generating clusters do not always occur near population centers.

3.3 Handling

As mentioned above, 1.7 million metric tons (79 percent) of the waste generated in Illinois in 1984 was handled

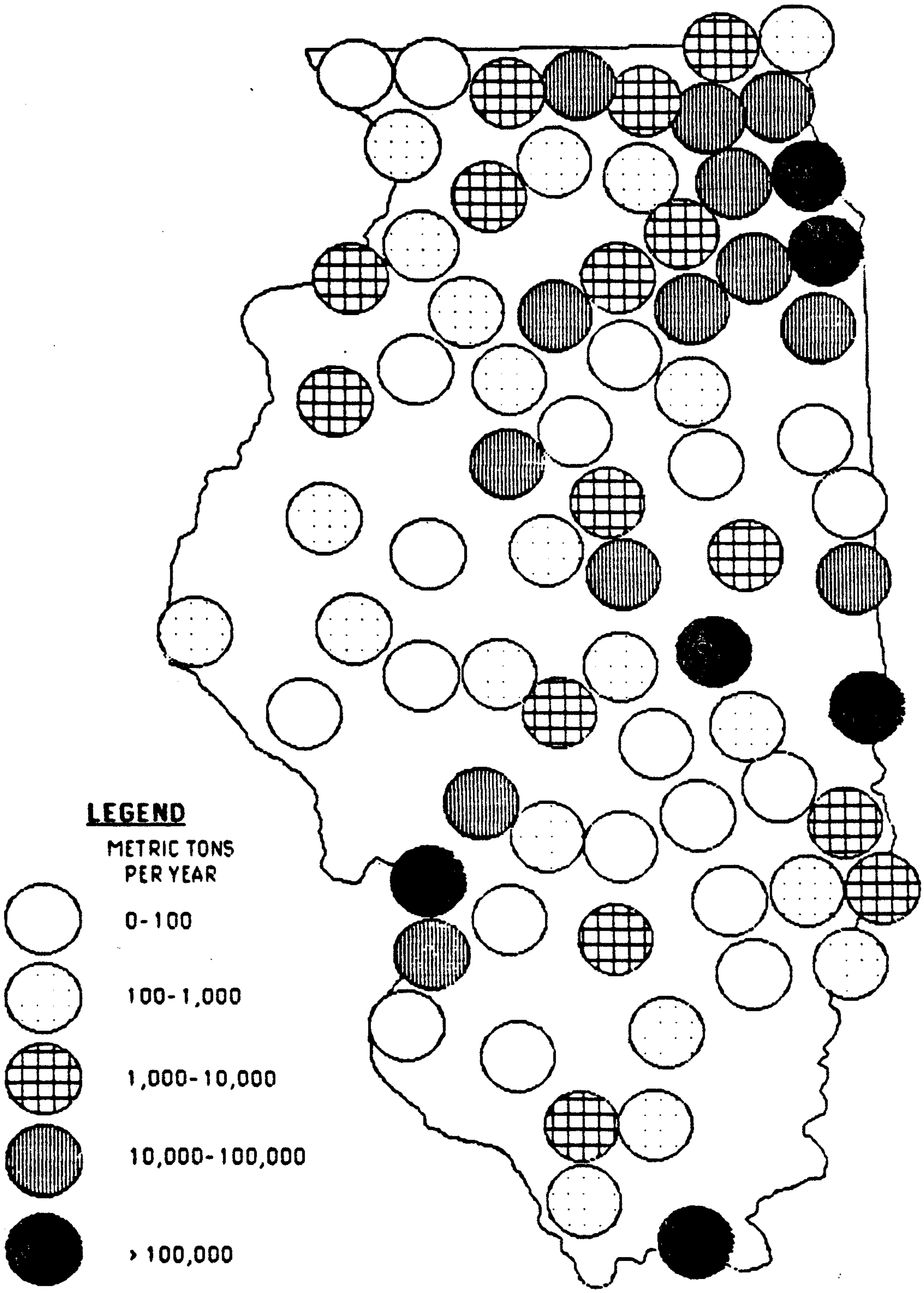

Figure 7. Generation Volumes by Cluster

on-site by 235 different generators. Just over 300,000 metric tons (14 percent) were shipped to commercial facilities in Illinois, and 143,500 metric tons (7 percent) were exported out of the state. In addition, 132,000 metric tons of waste were generated out-of-state and imported into Illinois for handling (see Figure 8).

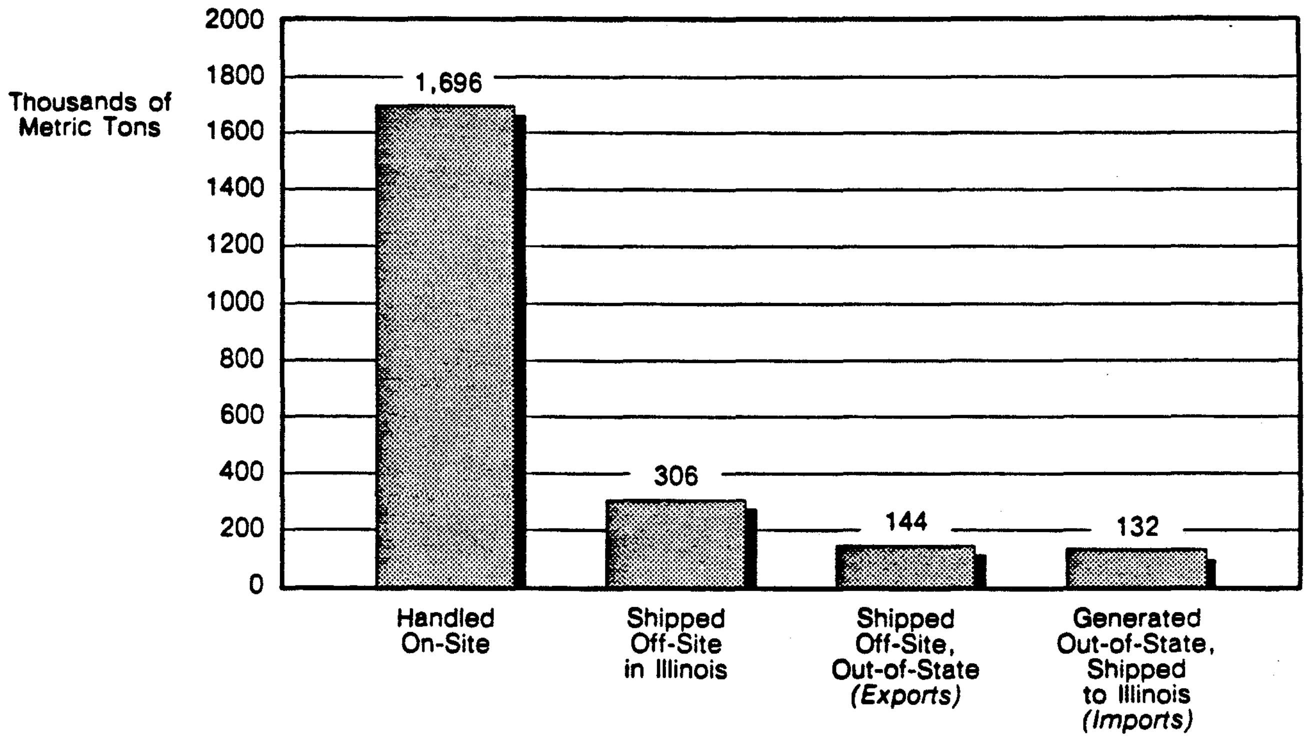

Figure 8. Transport and Handling Locations

3.3.1 On-Site Handling

The distribution by cluster of the amount of waste handled on-site is shown in Figure 9 on the next page. This distribution is very similar to the map showing generation by cluster, since so much of Illinois' waste was handled on-site. The most common methods of handling waste at on-site generators/TSDs are summarized in Figure 10. As might be expected, the treatments involving large volumes of dilute wastes, such as tank treatment and underground injection, dominate the on-site treatment profile.

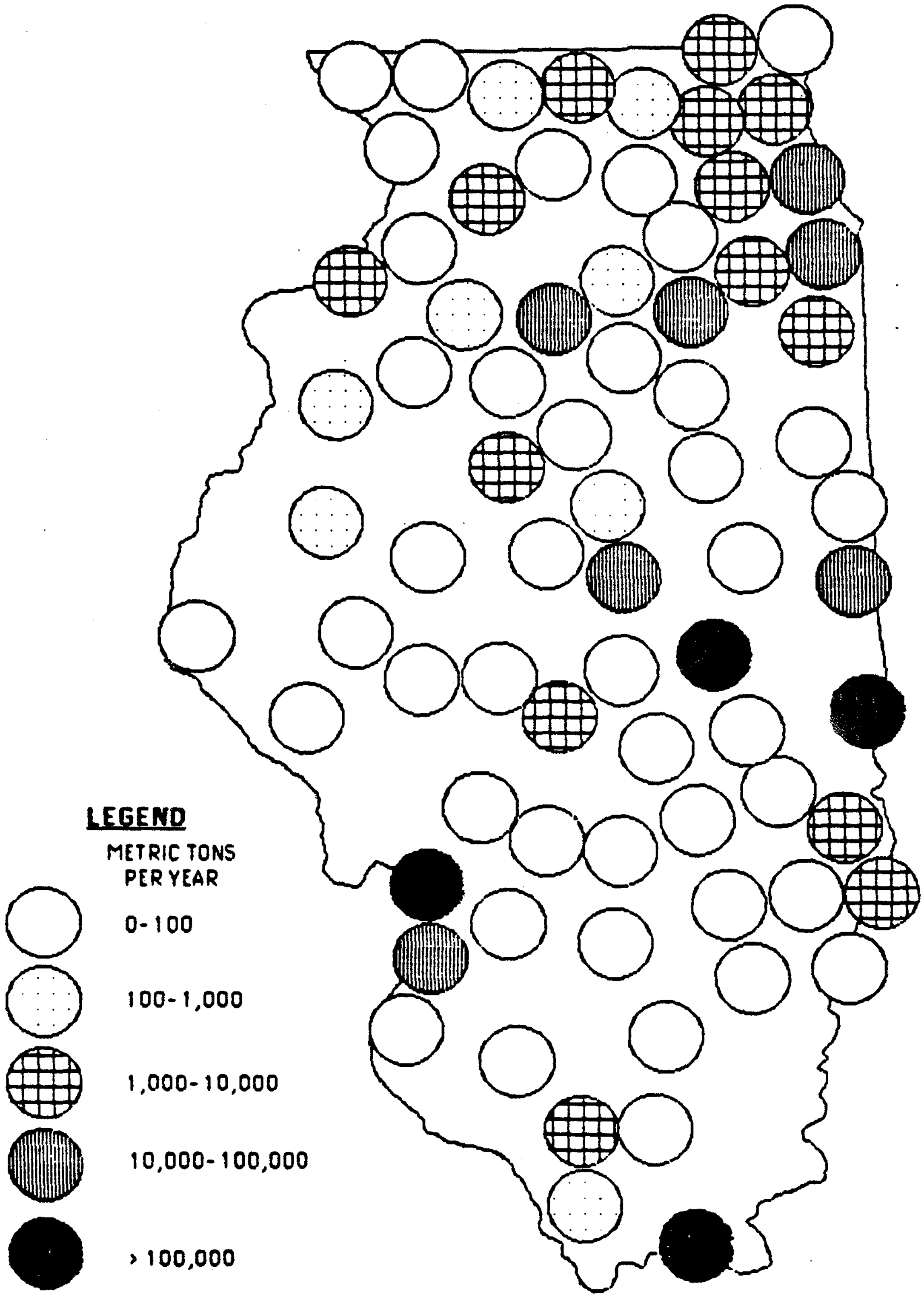

Figure 9. On-Site Handling Volumes by Cluster

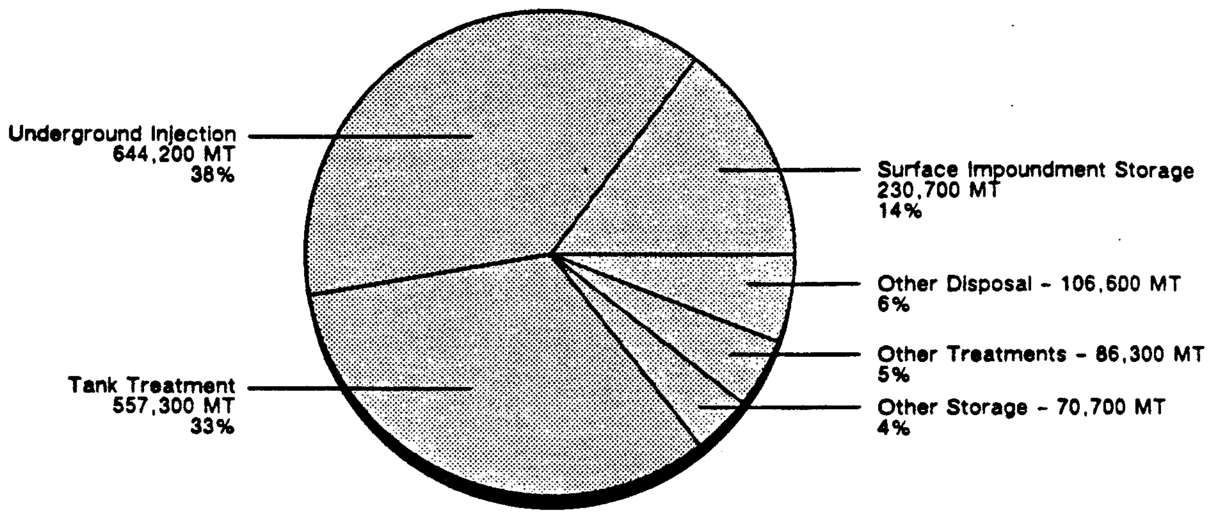

Figure 10. Handling Methods at On-Site Illinois TSDs

3.3.2 Off-Site Handling

Besides the 235 generators who also handled their waste on-site, our data list 54 commercial treatment, storage, and disposal facilities in Illinois (some of these have the same name, but different EPA ID numbers). The largest commercial TSD facilities, and the amount of waste handled by each in 1984, are listed in Table 4.

Company	City	Cluster	Metric Tons Handled
CID Processing #1	Calumet City	IL07	138,381
Chem-Clear	Chicago	IL05	105,326
CECOS International	Zion	IL01	39,912
Envirite	Harvey	IL07	22,981
Pfizer	East St. Louis	IL60	21,301
Peoria Disposal #1	Peoria	IL33	21,037
Environmental Waste Resources	Coal City	IL22	20,020
McKesson Envirosystems	Dolton	IL07	12,011
Litho Strip	Bridgeview	IL05	10,644

Table 4. Commercial TSDs Handling More than 10,000 Metric Tons per Year

There are commercial TSDs located in 19 of the 75 clusters in the state. The distribution by cluster of waste volume handled at commercial TSDs, including wastes imported into the state, is shown in Figure 11. The clusters with large handling volumes correspond to the locations of the large TSDs listed in Table 4.

The most common methods of handling waste at commercial TSDs (including imports and Illinois waste shipped off-site to Illinois TSDs) are summarized in Figure 12. Note that landfilling was the most common handling method identified in 1984 at commercial facilities. Also note that for almost one-third of the waste handled at commercial TSDs in Illinois, the handling method is an unspecified treatment, i.e., a treatment method other than tank treatment, surface impoundment, or incineration (specifics on these treatments are sometimes available in the comments section of the hard copies of the IEPA annual reports).

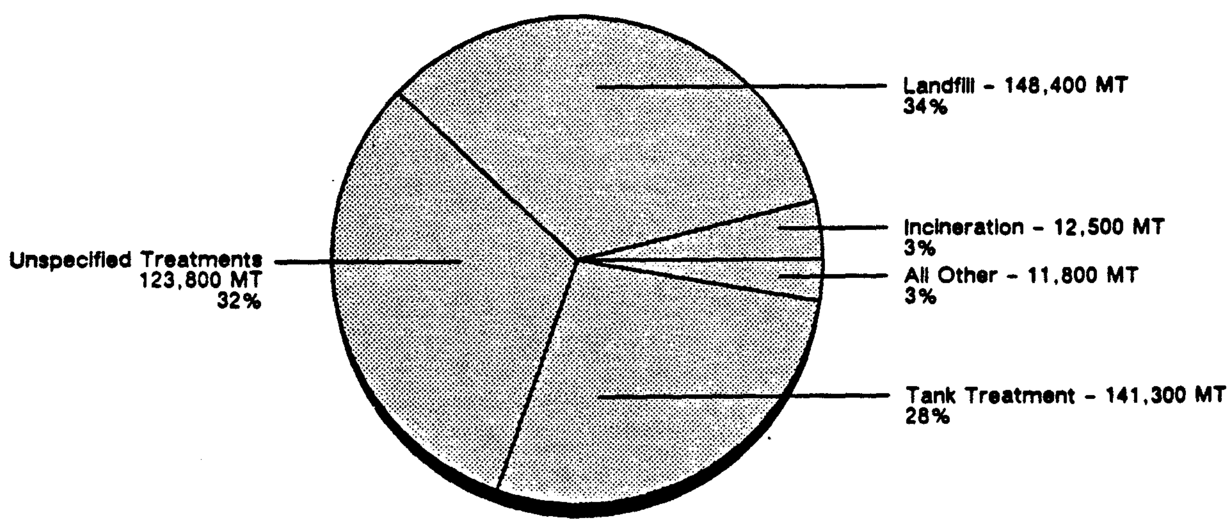

Figure 12. Handling Methods at Commercial TSDs in Illinois (Includes Imports)

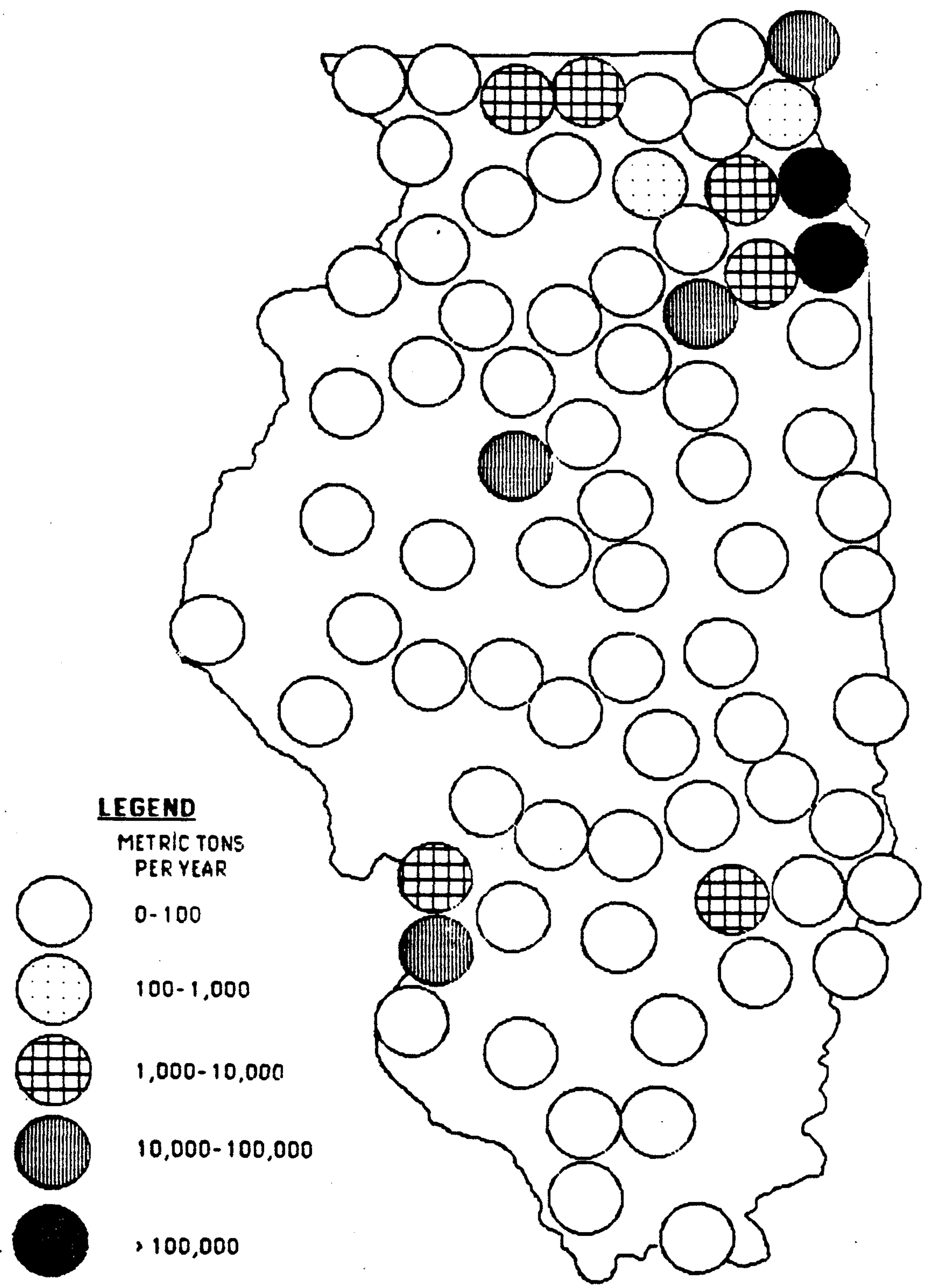

Figure 11. Off-Site Handling Volumes by Cluster

3.3.3 Landfills

In 1984, there were four commercial and one on-site landfills in 5 clusters in Illinois (one of the commercial landfills also disposes of self-generated wastes on-site). The commercial landfills disposed of 148,400 metric tons of waste in 1984, 53,200 metric tons of which (36 percent) came from out-of-state generators. The on-site landfill and the commercial landfill which is also a generator disposed of 59,400 metric tons of waste on-site. The locations of the Illinois land-based handlers, including landfills, are shown in Figure 13. The landfills and their volumes handled are detailed in Appendix C.

In the wake of Love Canal and other well-publicized Superfund sites, the American public is becoming more and more concerned about land disposal of hazardous wastes, especially in landfills. With the 1984 Hazardous and Solid Waste Amendments to RCRA, the U.S. Congress directed EPA to ban land disposal of untreated hazardous wastes. The state of Illinois has already instituted such a ban, which went into effect in January 1987, with case-by-case and blanket (e.g., all incinerator ash) exemptions allowed. This raises the question of what will be done with waste streams that were previously landfilled, which depends in part on what kinds of wastes these were. Some wastes, such as incinerator ash, will still be able to be landfilled under the Illinois ban. The waste types landfilled in Illinois (at both commercial and on-site landfills) in 1984 are shown in Figure 14, the most common being K062, spent pickle liquor from steel finishing operations. Depending on generator location and available alternative treatments, currently landfilled wastes may either be switched to a different handling method or simply be shipped to an out-of-state landfill with the Illinois land disposal ban in effect.

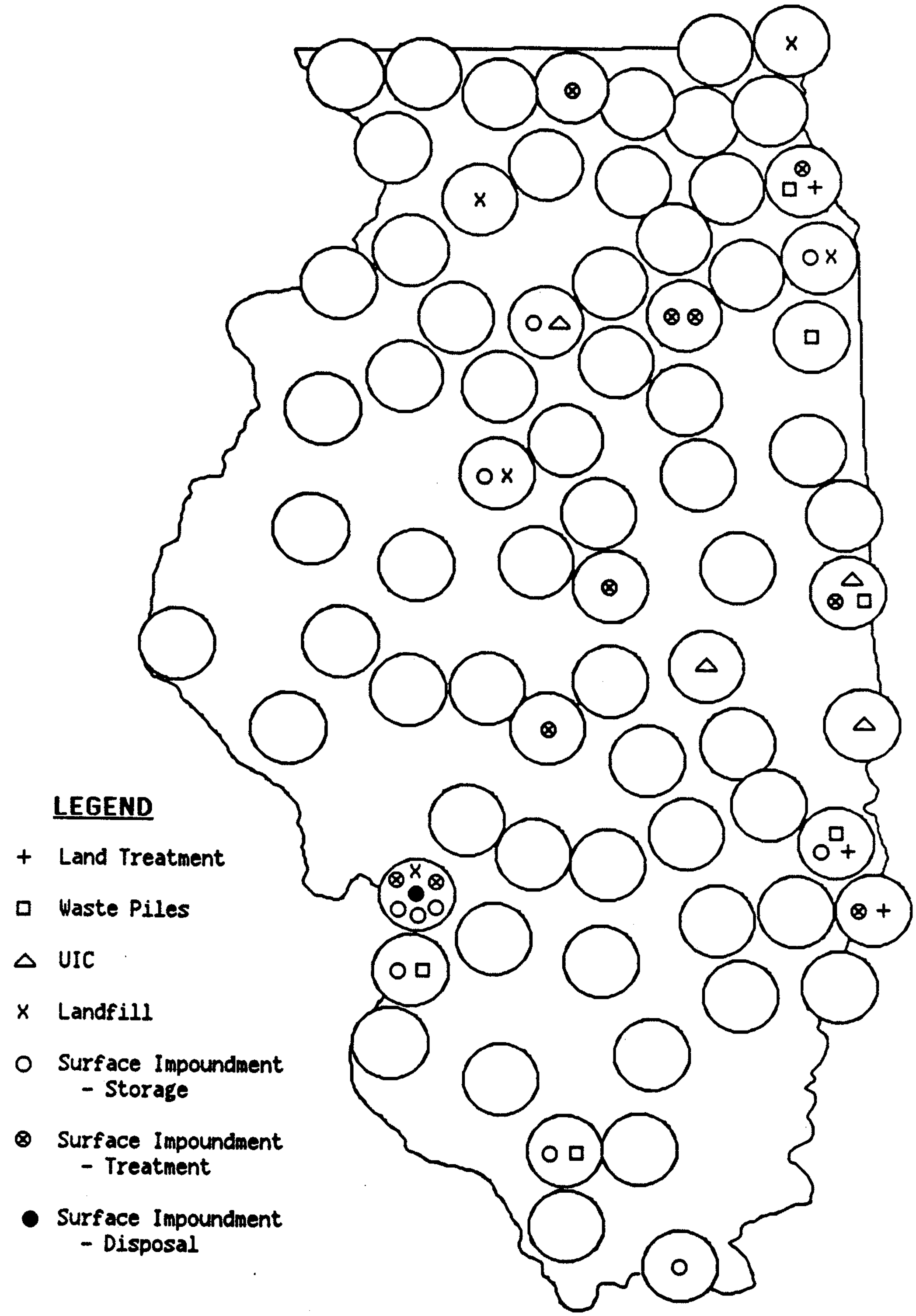

Figure 13. Land-Based Handler Locations

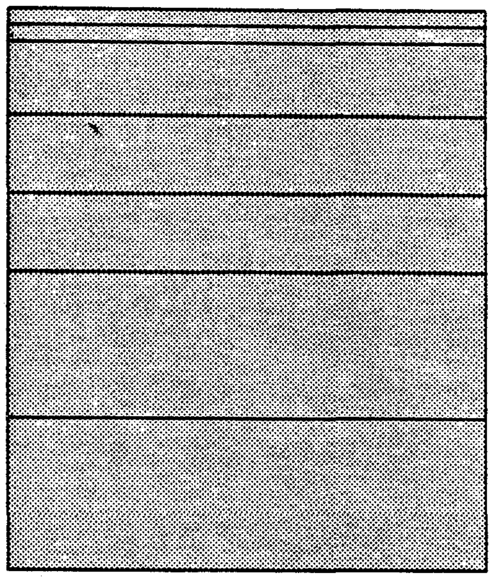

Figure 14. Types of Wastes Landfilled

3.3.4 Surface Impoundments

Surface impoundments can be another form of land disposal. They may also be used for storage or treatment of hazardous wastes. For this analysis, we have grouped all surface impoundments together for two reasons. First, it is not always clear how the impoundment is actually being operated, especially at on-site treatment sites. For instance, a treatment impoundment may eventually be closed as a landfill with the residual sludges contained in it. Second, from a risk perspective, there may not be significant differences between the three types of impoundments. For example, an active impoundment that is leaching to ground water presents a threat no matter what kind of impoundment it is, as long as it is in continual use. There were 21 surface impoundments in Illinois in 1984: one used for disposal, ten for treatment, and ten for storage. The locations of these are shown in Figure 13 on page 31. A list of surface impoundments and the volumes handled by each is included in Appendix C.

In 1984, 297,000 metric tons of waste were handled in surface impoundments in Illinois (all on-site). Of this, 37,000 metric tons were in disposal impoundments (impoundments to be closed as landfills), 30,000 metric tons were treated in impoundments, and 230,000 metric tons were stored in surface impoundments. The distribution of RCRA waste types handled in these impoundments is shown in Figure 15. K048, dissolved air floatation float from petroleum refining, is the most common waste in impoundments.

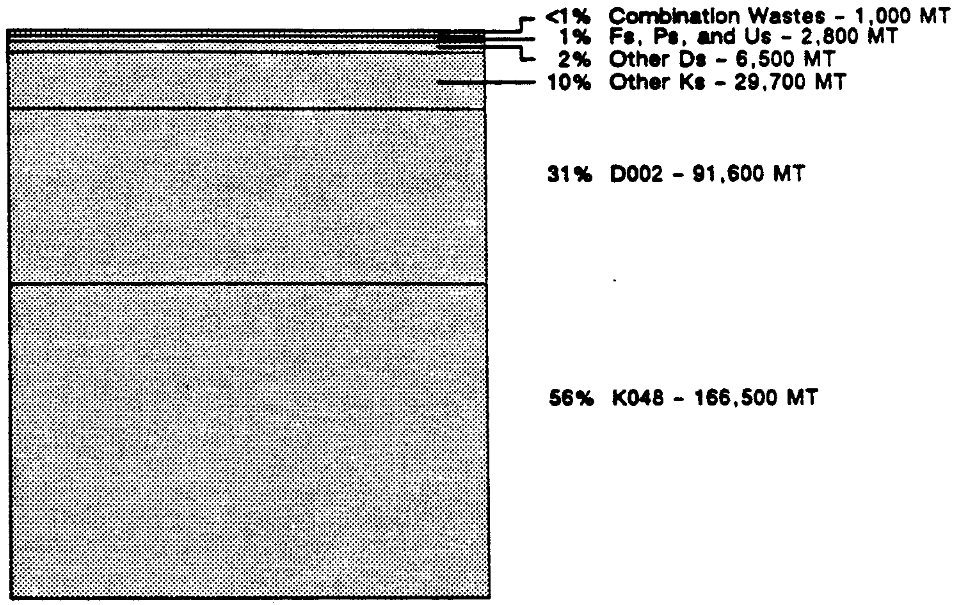

Figure 15. Types of Wastes in Surface Impoundments

3.3.5 Underground Injection

Underground injection is not now included in the Illinois land disposal ban, but may be restricted or banned in the future by U.S. EPA regulation. These wastes tend to be dilute and in large volumes. In 1984 in Illinois, four companies injected 675,000 metric tons of waste on-site. These injection locations are shown in Figure 13 on page 31. Almost half of the injected waste (49 percent) is classified as D002, basic or corrosive wastes. Another 41 percent of the injected waste is K032 (waste water sludge from chlordane production). The vast majority of the rest is either D004 (EP toxic from arsenic) or K062 (spent pickle liquor from steel finishing). These facilities are listed in Appendix C.

3.3.6 Other Land-based Technologies

Two methods of handling hazardous wastes are considered here: land treatment (disposal) and waste piles (storage) facilities using these handling methods are listed in Appendix C. Two petroleum companies treated 10,400 metric tons of waste on the land (on-site) in Illinois, along with a very small amount by a third company (in cluster IL05). These wastes are almost all petroleum refining wastes (K048-K052) with an additional 246 metric tons of D002 being land treated.

In addition, 26,800 metric tons of waste were stored in waste piles on-site at 8 generator locations. These are shown in Figure 13 on page 31. Emission control dust/sludge from steel production in electric furnaces, K061, makes up 76 percent of this amount, with U051, off-spec or waste creosote, accounting for another 15 percent. The rest is EP toxic metal wastes (7 percent) and other wastes from specific sources in the manufacture of inorganic chemicals and petroleum refining.

3.3.7 Incineration

Incineration of hazardous wastes is often regarded as an attractive handling option to destroy organic wastes. In 1984, there were nine facilities, including boilers, that incinerate or burn 16,000 metric tons of hazardous waste in Illinois, of which 10,000 metric tons was imported into the state. Incineration or boiler facilities are listed in Table 5.

Company	City	Cluster	Incinerated On Site (metric tons)	Incinerated from Off Site (metric tons)[1]	Total Metric Tons Incinerated
SCA Chemical Services	Chicago	IL05	31	8,596	8,627
Trade Waste Incineration	Sauget	IL60	0	3,741	3,741
Olin Corp.	East Alton	IL59	1,772	0	1,772
3-M	Cordova	IL15	1,022	0	1,022
Marathon Oil	Robinson	IL58	691	0	691
Spaulding Fibre	DeKalb	IL19	0	176	176
Norchem	Morris	IL22	5	0	5
General Electric	Mattoon	IL51	4	0	4
Savanna Army Depot Activity	Savanna	IL14	.06	0	.06
			3,525	12,513	16,038

[1] Includes imports.

Table 5. Incinerators/Boilers in Illinois

A summary of the waste types incinerated or burned in Illinois is shown in Figure 16. A more complete breakdown is given in Appendix C. Not surprisingly, almost half of the incinerated waste is D001, characteristic waste described as ignitable.

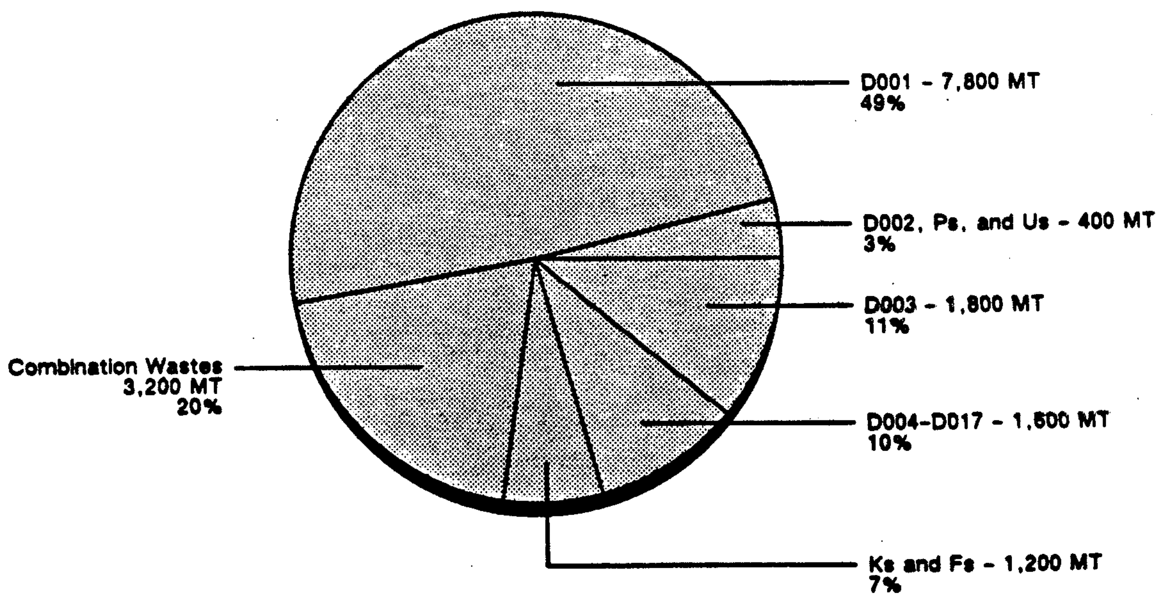

Figure 16. Types of Wastes Incinerated

3.4 Imports and Exports

There were 132,000 metric tons of waste imported into Illinois for handling from 714 generators in 33 different states. These wastes were shipped to 21 commercial facilities in Illinois. Almost half of this total came from generators in Indiana. Most of the rest came from other states bordering on Illinois (see Figure 17).

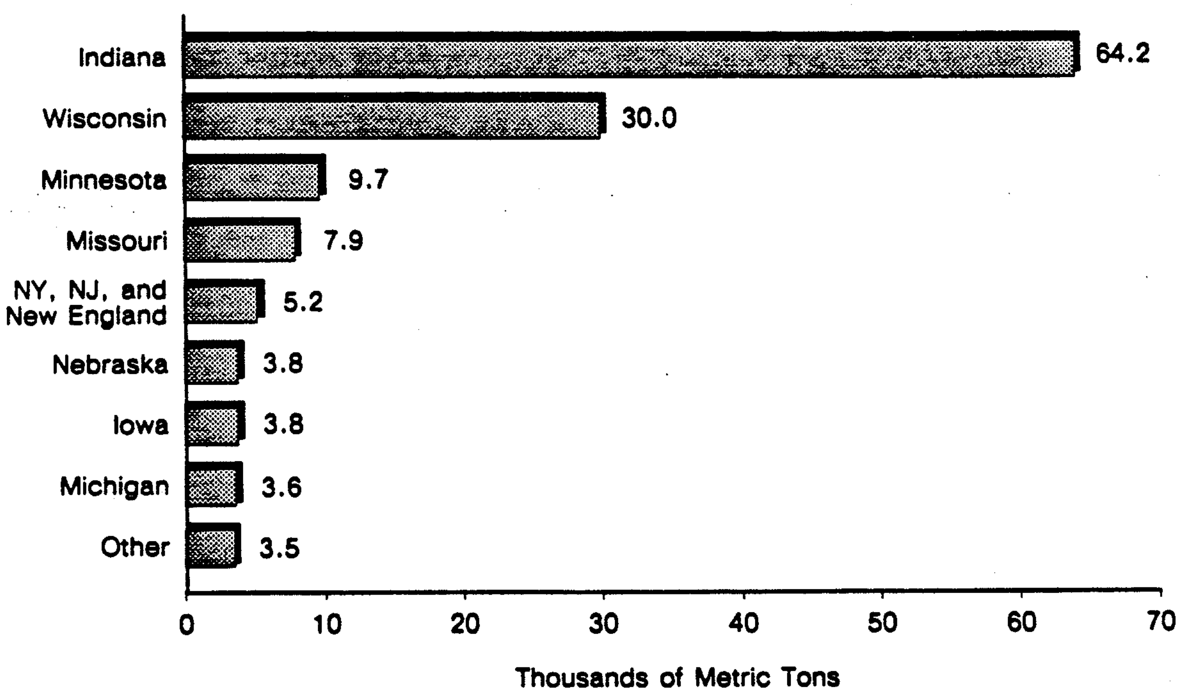

Figure 17. Waste Import Sources

In the 1986 Superfund Amendments and Reauthorization Act, Congress puts the burden on each state to show adequate handling capacity in order to quality for federal clean-up funds. Obviously, the imports and exports of hazardous wastes will affect and be affected by these capacity questions. In addition, state level regulations in any sending or receiving state, such as the Illinois land ban, will affect imports to and exports from Illinois. The types of wastes imported into the state are given in Figure 18.

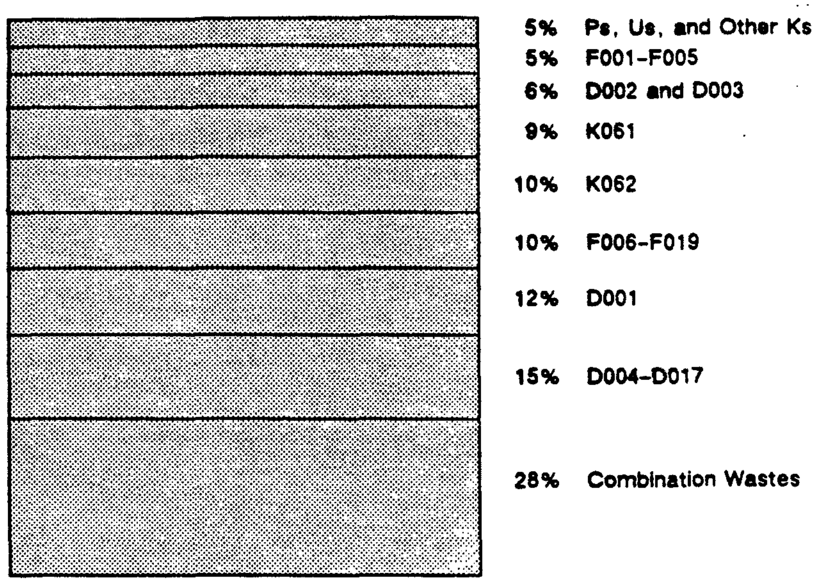

Figure 18. Types of Wastes Imported

The handling of imported wastes is shown in Figure 19, the most common method for imports in 1984 being landfill. Imported wastes went to three of the four commercial landfills in the state.

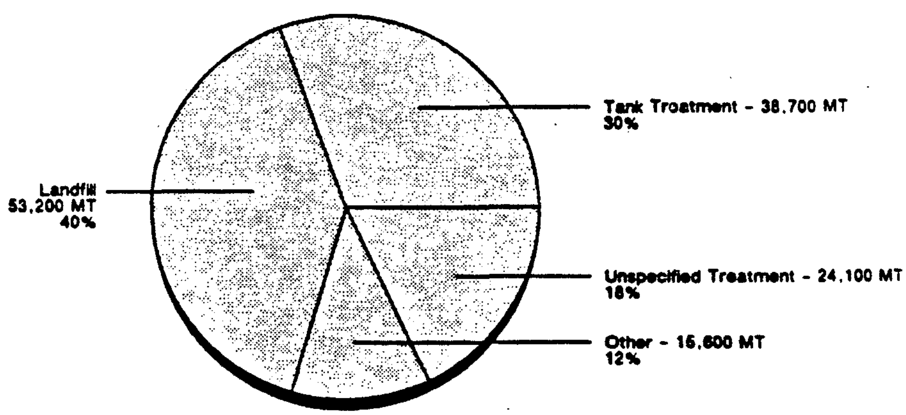

Figure 19. Handling of Imported Wastes

There were 143,500 metric tons of waste exported from 631 generators in Illinois for handling at 135 different facilities in 30 states (not including wastes exported from small quantity generators). Over 40 percent of this went to Indiana facilities (see Figure 20) and another 30 percent to Alabama (to the Chemical Waste Management facility in Emelle).

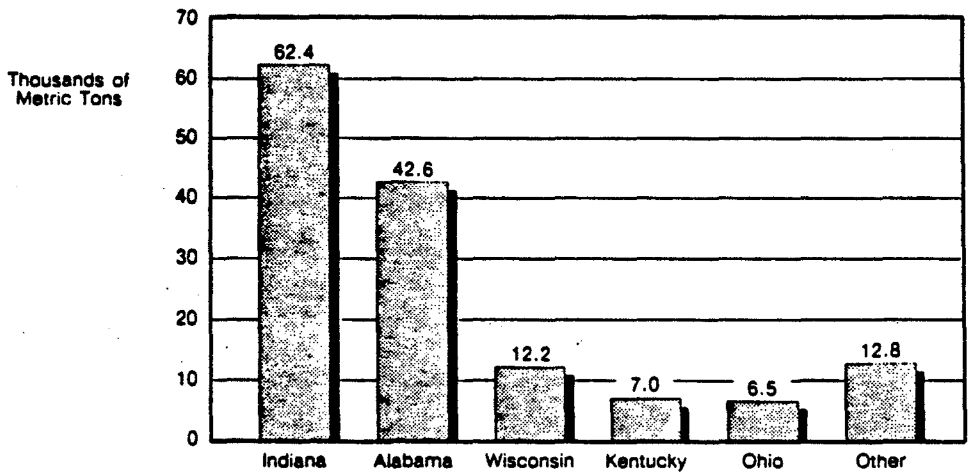

Figure 20. Waste Export Destinations

The types of wastes exported out of Illinois are outlined in Figure 21.

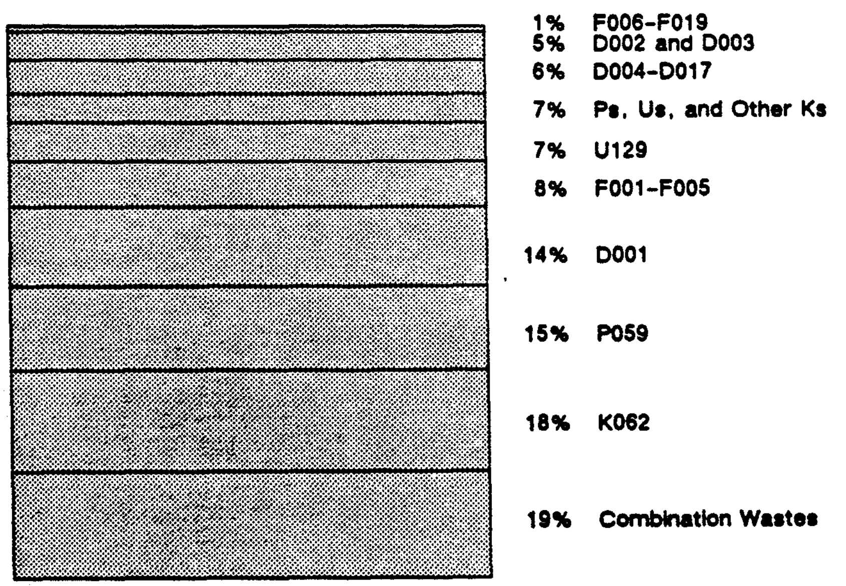

Figure 21. Types of Wastes Exported

The imports and exports seem to be as much of a function of geography rather than available treatment capacity for the waste type. For instance, there are significant waste flows (both ways) between Indiana and the Chicago area and between the East St. Louis area and Missouri. Some wastes however, such as those going to Alabama, probably do not have economical treatments available for them in Illinois. Note that we can not answer these questions more directly because the handling methods are not contained in the annual reports for wastes shipped out of Illinois.

3.5 Flows

The network of waste flows between clusters can provide important information about where handling facilities are available relative to the generators who produce the wastes eligible for each handling method. The largest cluster-to-cluster flows for 1984 are shown in Figure 22. Note that these only include clusters with large shipments from one cluster to another. A cluster with a TSD who collects waste from several other clusters in smaller amounts, although the total volume handled may be large, will not show up on this network diagram.

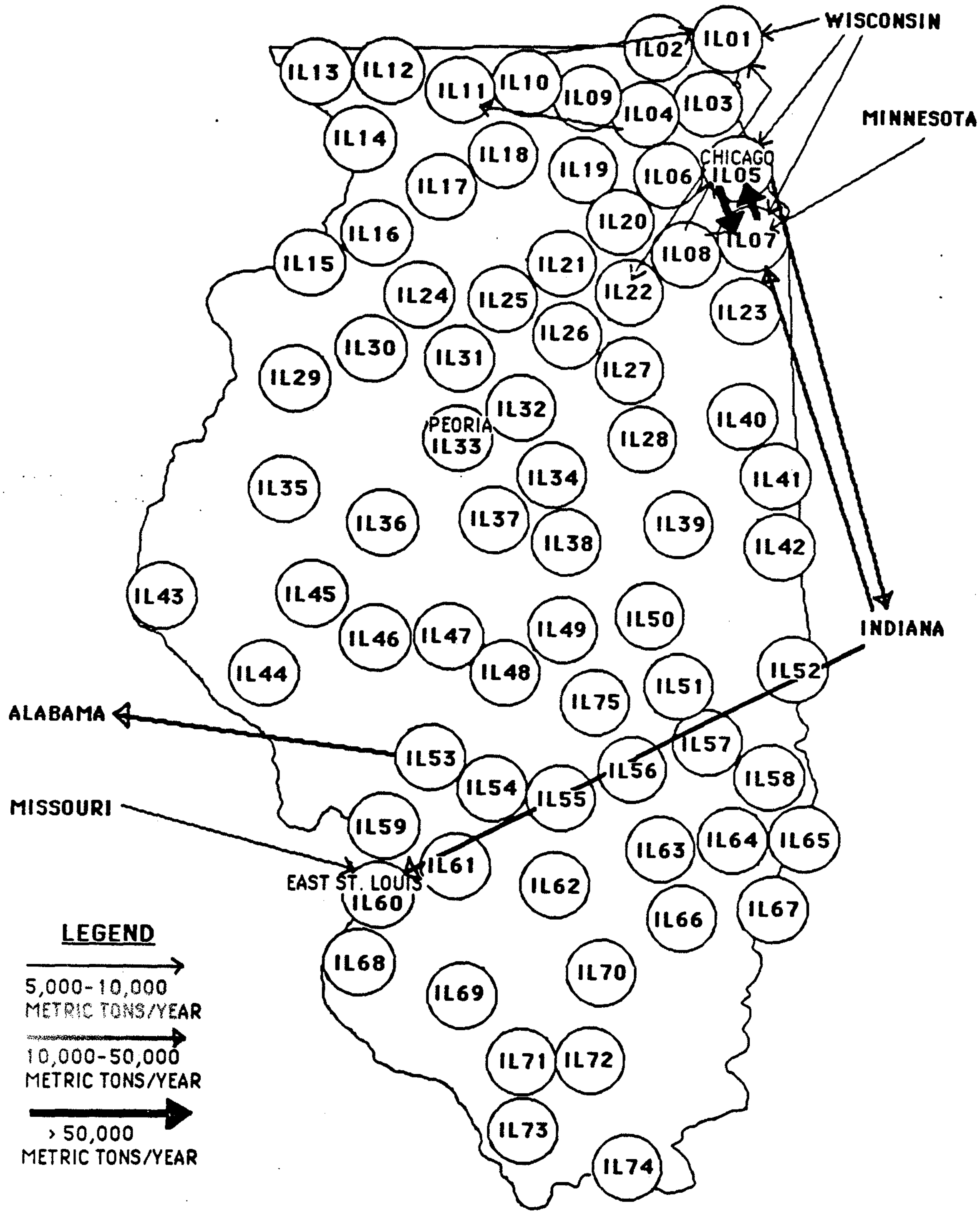

Figure 22. Major Flows Between Clusters

CHAPTER 4. MODEL RESULTS

4.1 BASELINE

Using the 1984 data on hazardous waste generation and handling provided by the Illinois HWRIC, we ran the Waste Planning Model for the baseline (current situation). The resulting risks are presented below, with dominant wastes, pollutants, management strategies, and exposure routes highlighted and discussed in depth.

Table 6 shows the baseline population incidence risks (over 70 years) for each exposure route and health effect. Please note that as explained in Section 2.6, the health risks presented here are conservative plausible upper-bound estimates. Moreover, these risks represent the incremental risk associated with hazardous waste activities. Finally, to offer some perspective, the population incidence numbers presented here (cases) occur across an exposed population of approximately 11 million people (total 1980 Illinois population was 11.5 million). Most of the exposed population reside in Illinois, but some portion is across the state border, particularly in the Chicago and East St. Louis metropolitan areas.

Almost all the air and groundwater risk is associated with cancer health effects. On the other hand, almost all the surface water risk is associated with the "other" health effects category. These effects are primarily hypertension

(cases)	Air	Surface Water	Ground Water	Total
Cancer	18	0.7	1.4×10^{-3}	19
Renal	0	6	0	6
Teratogenic	*	*	0	*
Neurological	0	0.01	0	0.01
Other	*	133	0	133
Total	18	140	1.4×10^{-3}	158

*Less than 1×10^{-3}

Table 6. Baseline Risks Over 70 Years

and FEP (a mild blood disorder) effects from lead exposures; the level of severity is not comparable to carcinogenic effects, for instance. It is also important to note that these "cases" are morbidity rather than mortality numbers (i.e., cases of disease rather than deaths).

Almost all of the air risk is from drum and tank storage and comes from volatilization of organic chemicals due to spills, leaks, and transfer operations (see Table 7).

(cases over 70 years)	Cancer
Drum and Tank Storage:	
F001/DCM	6.7
U210/PERC	2.4
F001/TCE	2.1
F002/DCM	1.7
U080/DCM	1.2
F001/PERC	0.8
U228/TCE	0.8
F001/TCA	0.7
4044/chloroform	0.4
F002/TCA	0.2
U226/TCA	0.2
All other pollutants	0.7
All Other Management Strategies	0.1
Total	18.0

Table 7. Major Air Risk Contributors

Table 8 outlines the major contributors to risk from surface water exposures. The risk from tank treatment is from effluent discharge.

(cases over 70 years)	Cancer	Renal	Other
Waste Piles:			
D008/Pb	-	-	0.3
All other pollutants	-	-	-
pH Adjustment (tank):			
K062/Cr+6	0.4	6.1	126.9
F001/Perc	0.2	-	-
D004/AS	0.1	-	-
D002/Pb	-	0.2	4.3
F006/Pb	-	-	0.7
D003/Pb	-	-	0.7
D008/Pb	-	-	0.3
All other pollutants	-	-	0.1
All Other Management Strategies	-	-	-
Total	0.7	6.4	133.3

Note: Blanks represent <0.1.

Table 8. Major Surface Water Risk Contributors

Table 9 breaks down the baseline cancer risk results by management strategy.

The major contributor to cancer risk associated with the handling of hazardous waste in the state is drum and tank storage. The release of pollutants from spills, leaks and transfer operations associated with the 152 metric tons in storage each day accounts for almost all of the estimated excess cancer risk.

(cases over 70 years)			
	Air	Surface Water	Ground Water
Drum and Tank Storage	1.79 E+1	0	1.36 E-3
Landfill	1.86 E-2	0	4.06 E-5
Surface Impoundment(D84)	0	0	0
Surface Impoundment (T02)	3.85 E-6	3.37 E-9	0
Surface Impoundment (S04)	1.90 E-7	3.75 E-7	0
Waste Piles	3.29 E-4	1.75 E-2	0
UIC	3.28 E-8	0	7.23 E-7
Liquid Injection Incineration	1.36 E-2	0	0
Rotary Kiln Incineration	7.91 E-2	0	0
pH Adjustment (Tank)	0	7.16 E-1	3.38 E-5
TOTAL	1.80 E+1	7.34 E-1	1.43 E-3

Table 9. Baseline Cancer Risks by Management Strategy

Table 10 shows the quantity of waste handled by each of 10 handling methods evaluated by the Waste Planning Model (see Appendix A for definition of size categories). Note that we have grouped handling methods together in several places (e.g., most forms of aqueous treatment are included in the pH adjustment category). The annual costs of handling the waste is also shown in the table. A total of $598 million (1985 dollars) is associated with the handling of the two million metric tons of hazardous waste generated in Illinois. Transportation costs are estimated to be $1.9 million per year (figured at $0.2 per mile). The number of accidents associated with the transportation of this waste is estimated to be 0.12 accidents per year.

		(daily)				
		On-Site Facilities		Off-Site Facilities		
		Small	Large	Small	Large	Total*
Drum and tank storage	MT	0	120	0	32	152
	$	0	12,445	0	3,356	15,801
Surface Impoundment (D84)	MT	0	100.6	0	0	100.6
	$	0	10,155	0	0	10,155
Waste Piles	MT	73.5	0	0	0	73.5
	$	53,350	0	0	0	53,350
Liquid Injection Incineration	MT	.097	1.89	0.51	1.147	3.6
	$	19.4	189	102	115	425
Rotary Kiln Incineration	MT	5	2.7	9.3	23.3	37.6
	$	1,501	400	2,788	3,499	8,188
pH adjustment	MT	7	1,665	5	720	2,397
	$	4,006	474,072	1,427	205,105	684,610
UIC	MT	1,765	0	0	0	1,765
	$	511,805	0	0	0	511,805
Landfill	MT	191	0	407	0	598
	$	98,970	0	81,308	0	180,278
Surface Impoundment (T02)	MT	81.5	0	0	0	81.5
	$	87,791	0	0	0	87,791
Surface Impoundment (S04)	MT	21.2	611	0	0	632
	$	22,883	61,646	0	0	84,529
TOTAL ANNUAL VOLUME* (Thousands)	MT	782.8	912.9	153.8	283.7	2,145
TOTAL ANNUAL COST* (Millions)	$	284.8	204.0	31.3	77.4	597.5

*Totals may not add due to rounding.

Table 10. Baseline Costs and Volumes Handled

4.2 MANAGEMENT SCENARIOS

In addition to the baseline, we have used the model to simulate four alternative management scenarios--a ban on UIC, two land disposal bans, and the establishment of a metal recovery facility. A description of these scenarios, along with the results for each and comparisons to the baseline, are discussed below.

4.2.1 Underground Injection Ban

In order to simulate the human health changes that would be associated with a ban on the injection of hazardous waste in Illinois, we have rerun the Waste Planning model switching all wastes reported as injected to on-site aqueous treatment. The on-site aqueous treatment is modelled as pH adjustment. Please note that we have characterized the injected waste based on actual test results of wastes injected in Illinois.

This scenario results in 1,003 metric tons per day being switched from injection to aqueous treatment and a slight (0.6 percent) decrease in total costs expended across the state. A slight increase in health risk results from the increased emissions to surface water. Note that there is no apparent decrease in air or groundwater risks because the injection of wastes in the baseline showed these risks to be on the order of E-8 (see Table 9). There is also no change in transportation risk (all injection was on-site; all aqueous treatment is assumed on-site).

(cases)

	Air	Surface Water	Ground Water	Total
Cancer	18.0	6	1.4×10^{-3}	24
Renal	0	6	0	6
Teratogenic	*	*	0	*
Neurological	0	.01	0	.01
Other	*	133	0	133
Total	18	146	1.4×10^{-3}	164

*Less than 1×10^{-3}

Table 11. UIC Ban Risks Over 70 Years

4.2.2 Land Ban I

Under the land ban scenarios examined, certain wastes were excluded from disposal on or in the land. Under the first land ban scenario examined, D001 through D009, F006 and K061 wastes were excluded from land disposal. These wastes were switched to a variety of handling methods based on the other methods currently used for the wastes in question. Specifically, 625 tons per day of wastes was shifted from landfill and surface impoundments to aqueous treatment and incineration. The human health impact of these switches is shown in Table 12: significant increase in the risks from surface water. A slight (0.8 percent) decrease in management costs also results. Transportation risk increases 8 percent to 0.13 accidents per year; transportation costs increase to $2.0 million per year.

(cases)

	Air	Surface Water	Ground Water	Total
Cancer	18	0.8	1.4×10^{-3}	19
Renal	0	10.1	0	10
Teratogenic	*	2×10^{-3}	0	2×10^{-3}
Neurological	0	0.2	0	.02
Other	*	169	0	169
Total	18	180	1.4×10^{-3}	198

*Less than 1×10^{-3}

Table 12. Land Ban I Risks Over 70 Years

4.2.3 Land Ban II

The second land ban scenario examined excluded two additional wastes from land disposal: K048 and K051. As shown in Table 13, the risk changes are insignificant despite the switching of an additional 550 metric tons per day versus the Land Ban I. This is primarily due to the fact that the additional K wastes examined under this scenario contain metals which do not volatilize (chromium, lead). As a result, little risk is associated with these wastes in the baseline (and therefore there is little risk to be shifted when land disposal is banned). Costs, however, increase approximately 5 percent. Transportation costs and accidents are the same as under the Land Ban I scenario.

(cases)

	Air	Surface Water	Ground Water	Total
Cancer	18	0.8	1.4×10^{-3}	19
Renal	0	10.1	0	10
Teratogenic	*	2×10^{-3}	0	2×10^{-3}
Neurological	0	.02	0	.02
Other	*	169	0	169
Total	18	180	1.4×10^{-3}	198

*Less than 1×10^{-3}

Table 13. Land Ban II Risks Over 70 Years

4.2.4 Central Metals Recovery Facility

We also simulated the impact of a central metals recovery facility. The facility is modeled based on the description contained in Feasibility of a Central Recovery Facility for The Metal Finishing Industry in Cook County (Illinois ENR, November, 1986). The facility is assumed to recover 98 percent of the metals contained in various metal-containing sludges (F006, F007, F008, and F009); the unrecovered metals are discharged to surface water. We have located the hypothetical facility in Cluster IL04 (just west of Chicago) and assumed it accepts wastes from Clusters IL01 to IL09, IL19, and IL20 (see Figure 3).

Using these assumptions, a total of only 26.2 metric tons are processed by the central recovery facility annually. This small shift results in no distinguishable change from the baseline human health risks and a slight increase in transportation accidents and cost (0.8 percent).

CHAPTER 5. RECOMMENDATIONS FOR FUTURE WORK

The study presented here has examined the baseline situation in Illinois and attempted to provide some insight into the impact of planned or potential changes in the current pattern of hazardous waste generation and disposal. There are several areas where future work would improve our estimation of effects and our understanding of the key factors involved in the determination of impacts. These areas are each described below:

- Incorporate 1985 data. This would be a key improvement. Basic data comparisons could be carried out to examine trends in generation, handling, and disposal. More up-to-date risk and cost estimates would also be possible. This would also provide IHWRIC with an excellent way to learn to use the Waste Planning Model.

- Improve waste composition data. At present, the model uses one characterization for each RCRA waste code. The characterization is based on national analyses of wastes. The characterizations could be improved by using actual Illinois-based monitoring data for large-volume or high-risk wastes (such as was done for the injected wastes in this study). Another more complicated option would be to allow multiple characterizations for certain RCRA waste streams; the characterization could be matched to specific generators.

- Improve cost data. By contacting generators and major handlers of Illinois waste, more specific cost estimates could be developed. This would be a straightforward task which would serve to tailor the Waste Planning Model and its output more to the Illinois situation.

- Expand analysis of scenarios presented here. In general, the scenarios examined here did not have a big impact on risk or cost because the scenarios, which were selected early in the study, did not in fact target what turned out to be large quantities of waste or risk. The Land Ban and Central Recovery Facilities could both be improved by expanding the waste codes and geographic areas considered in the analysis. For example, by expanding the geographic area served by the Central Recovery Facility to the entire state, a much greater quantity of waste would be handled and more meaningful results would be obtained.

- Simulate other waste management scenarios. Any waste management policy or regulation that can be translated into changes in generation or disposal practices, location, or costs can be evaluated in the model in terms of human health impact, transportation effects, and cost. Some interesting candidates for examination include assessing the impact of the change to the TCLP method to determine whether or not a waste is hazardous and assessing the impact of a major new incinerator.

- Expand release, fate and transport model. Release routes, release mechanisms and models, and fate and transport models are based on previous U.S. EPA work, but are not all inclusive. For instance, addition of a surface water exposure route for surface impoundments and a fate and transport model for lake water might be useful additions to improve the analysis for Illinois.

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Appendix A

MODEL DETAILS

Exhibit A-1

WASTE COMPOSITIONS FOR D, F, AND K WASTE CODES

WASTE	FRACTION NONWATER	HEAT CONTENT (KJ/KG)	POLLUTANT 1	FRACTION OF WASTE	POLLUTANT 2	FRACTION OF WASTE	POLLUTANT 3	FRACTION OF WASTE	POLLUTANT 4	FRACTION OF WASTE	POLLUTANT 5	FRACTION OF WASTE
D000	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
D001	0.70	20755	Methyl Ethyl Ketone	0.558750	Benzene	0.00055	Xylene,m-,p-,o-	0.0726	Nitrobenzene	0.0250	Toluene	0.0342
D002	0.14	0	Chromium VI	0.000080	Toluene	0.00005	Lead	0.0004		0.0000		0.0000
D003	0.06	399	Chromium VI	0.000001	Lead	0.00499	Copper	0.0000	Nickel	0.0000		0.0000
D004	0.48	0	Arsenic	0.000100		0.00000		0.0000		0.0000		0.0000
D005	0.34	0	Barium	0.002000		0.00000		0.0000		0.0000		0.0000
D006	0.20	0	Cadmium	0.000020		0.00000		0.0000		0.0000		0.0000
D007	0.44	0	Chromium VI	0.000076		0.00000		0.0000		0.0000		0.0000
D008	0.48	0	Lead	0.000087		0.00000		0.0000		0.0000		0.0000
D009	0.91	0	Mercury	0.000004		0.00000		0.0000		0.0000		0.0000
D010	0.00	0	Selenium	0.000100		0.00000		0.0000		0.0000		0.0000
D011	0.01	0	Silver	0.000500		0.00000		0.0000		0.0000		0.0000
D012	0.90	5000	Endrin	0.000020		0.00000		0.0000		0.0000		0.0000
D013	0.10	0	Lindane	0.000040		0.00000		0.0000		0.0000		0.0000
D014	0.10	5000	Methoxychlor	0.000010		0.00000		0.0000		0.0000		0.0000
D015	0.10	0	Toxaphene	0.000050		0.00000		0.0000		0.0000		0.0000
D016	0.91	0	Mercury	0.000004		0.00000		0.0000		0.0000		0.0000
D017	0.00	0	Silvex, 2,4,5-TP	0.000100		0.00000		0.0000		0.0000		0.0000
D018	0.10	0		0.000000		0.00000		0.0000		0.0000		0.0000
D019	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
DOMX	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
DXXX	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
F001	0.90	10667	Trichloroethylene	0.150000	Trichloroethane,1-1-1-	0.15000	Dichloromethane	0.1500	Tetrachloroethylene	0.1500		0.0000
F002	0.67	4405	Trichloroethane,1-1-1-	0.036500	Dichloromethane	0.03650	Chlorobenzene	0.0150	Tetrachloroethane,1-1-1-	0.0268	Tetrachloroethane,1-1-2-	0.0268
F003	0.69	13125	Xylene,m-,p-,o-	0.250000		0.00000		0.0000		0.0000		0.0000
F004	1.00	24700	Nitrobenzene	0.500000		0.00000		0.0000		0.0000		0.0000
F005	0.82	27745	Toluene	0.110000	Methyl Ethyl Ketone	0.11000		0.0000		0.0000		0.0000
F006	0.06	0	Cyanides NOS	0.001185	Chromium VI	0.00045	Cadmium	0.0023	Lead	0.0003	Nickel	0.0024
F007	0.05	0	Cadmium	0.001000	Copper	0.00140	Cyanides NOS	0.0008	Chromium VI	0.0017	Nickel	0.0150
F008	0.05	0	Copper	0.000955	Chromium VI	0.00036	Cadmium	0.0002	Lead	0.0002	Nickel	0.0019
F009	0.05	0	Cadmium	0.001000	Copper	0.00140	Cyanides NOS	0.0008	Chromium VI	0.0017	Nickel	0.0150
F010	0.20	2300	Cyanides NOS	0.050000		0.00000		0.0000		0.0000		0.0000
F011	0.00	0	Cyanides NOS	0.000000		0.00000		0.0000		0.0000		0.0000
F012	0.02	11000	Cyanides NOS	0.017600		0.00000		0.0000		0.0000		0.0000
F013	0.00	0	Cyanides NOS	0.000000		0.00000		0.0000		0.0000		0.0000
F015	0.10	0	Cyanides NOS	[illegible]		0.00000		0.0000		0.0000		0.0000
F017	0.10	0	Cyanides NOS	0.100000		0.00000		0.0000		0.0000		0.0000
F018	0.10	0		0.100000		0.00000		0.0000		0.0000		0.0000
F019	0.10	100	Cyanides NOS	[illegible]	Chromium VI	0.00001		0.0000		0.0000		0.0000
F028	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
FOMX	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K001	0.40	13892	Pentachlorophenol	0.000516	Acenaphthene	0.00020	Chrysene	0.0001		0.0000		0.0000
K002	0.10	0	Lead	0.000760	Chromium VI	0.00216		0.0000		0.0000		0.0000
K003	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K004	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K005	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K011	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K013	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000

Exhibit A-1

(Continued)

WASTE	FRACTION NONWATER	HEAT CONTENT (KJ/KG)	POLLUTANT 1	FRACTION OF WASTE	POLLUTANT 2	FRACTION OF WASTE	POLLUTANT 3	FRACTION OF WASTE	POLLUTANT 4	FRACTION OF WASTE	POLLUTANT 5	FRACTION OF WASTE
K014	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K015	1.00	28000	Trichlorobenzene,1-2-4-	0.000000	Hexachlorobenzene	0.00000	Toluene	0.0000	Benzyl Chloride	0.0000		0.0000
K016	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K017	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K018	1.00	640	Dichloroethane, 1-2-	0.011000	Hexachlorobenzene	0.02150	Hexachlorobutadiene	0.0215	Trichloroethylene	0.0320		0.0000
K019	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K020	1.00	9300	Vinyl Chloride	0.002000	Tetrachloroethane,1-1-1-	0.10500	Dichloroethane, 1-2-	0.2420	Trichloroethane,1-1-1-	0.2720	Tetrachloroethane,1-1-2-	0.1050
K022	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K023	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K027	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K030	1.00	9300	Hexachlorobenzene	0.200000	Tetrachloroethane,1-1-1-	0.14650	Hexachlorobutadiene	0.3380	Tetrachloroethane,1-1-2-	0.1465		0.0000
K032	0.03	650	Hexachlorocyclopentadien	0.007000		0.00000		0.0000		0.0000		0.0000
K034	0.90	3000	Hexachlorocyclopentadien	0.247000		0.00000		0.0000		0.0000		0.0000
K035	0.15	1200	Dibenzo(1,2 5,6)anthrace	0.000010	Indeno(1-2-3-cd)pyrene	0.00001	Fluoranthene	0.0001	Benzo(A)pyrene	0.0001	Benzo(b)fluoranthene	0.0001
K035	0.15	1200	Napthalene	0.000010	Chrysene	0.00001	Acenaphthalene	0.0020	Benzo(A)anthracene	0.0010		0.0000
K044	0.06	400		0.005000		0.00000		0.0000		0.0000		0.0000
K045	1.00	32000	Trinitrotoluene,2-4-6-	0.036500		0.00000		0.0000		0.0000		0.0000
K046	0.06	400	Lead	0.005000		0.00000		0.0000		0.0000		0.0000
K047	0.22	0	Trinitrotoluene,2-4-6-	0.000130		0.00000		0.0000		0.0000		0.0000
K048	0.21	5433	Chromium VI	0.000008	Lead	0.00000		0.0000		0.0000		0.0000
K049	0.50	20000	Lead	0.000003	Chromium VI	0.00001		0.0000		0.0000		0.0000
K050	0.39	2000	Chromium VI	0.000010	Lead	0.00003		0.0000		0.0000		0.0000
K051	0.37	8000	Chromium VI	0.000004	Lead	0.00008		0.0000		0.0000		0.0000
K052	0.58	3500	Chromium VI	0.000001	Lead	0.00063		0.0000		0.0000		0.0000
K061	0.50	0	Cadmium	0.000163	Chromium VI	0.00064	Lead	0.0024		0.0000		0.0000
K062	0.20	0	Chromium VI	0.000842	Lead	0.00758		0.0000		0.0000		0.0000
K064	1.00	1000	Lead	0.000000		0.00000		0.0000		0.0000		0.0000
K066	1.00	1000	Lead	0.000000		0.00000		0.0000		0.0000		0.0000
K067	1.00	1000	Lead	0.000000		0.00000		0.0000		0.0000		0.0000
K068	1.00	1000	Lead	0.000000		0.00000		0.0000		0.0000		0.0000
K069	0.25	0	Cadmium	0.000085	Chromium VI	0.00001	Lead	0.0130		0.0000		0.0000
K071	0.80	0	Mercury	0.000160		0.00000		0.0000		0.0000		0.0000
K073	1.00	2600	Chloroform	0.740000	Carbon Tetrachloride	0.11000		0.0000		0.0000		0.0000
K078	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K082	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K083	0.99	36400	Nitrobenzene	0.022000	Benzene	0.05800	Aniline	0.9070		0.0000		0.0000
K085	1.00	14000	Hexachlorobenzene	0.100000		0.00000		0.0000		0.0000		0.0000
K086	0.07	0	Lead	0.000760	Chromium VI	0.00015	Toluene	0.0001		0.0000		0.0000
K087	1.00	0	Napthalene	0.150000	Phenol	0.00170		0.0000		0.0000		0.0000
K088	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K091	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K093	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K094	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K100	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K101	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K102	0.00	0		0.000000		0.00000		0.0000		0.0000		0.0000
K106	0.57	0	Mercury	0.021000		0.00000		0.0000		0.0000		0.0000

Exhibit A-2

WASTE COMPOSITIONS FOR INJECTED WASTES (from monitoring reports)

WASTE	FRACTION NONWATER	HEAT CONTENT (KJ/KG)	POLLUTANT 1	FRACTION OF WASTE	POLLUTANT 2	FRACTION OF WASTE	POLLUTANT 3	FRACTION OF WASTE	POLLUTANT 4	FRACTION OF WASTE	POLLUTANT 5	FRACTION OF WASTE
VELS	0.01	0	Chloroform	0.00001200	Carbon Tetrachloride	0.00000042	Hexachlorocyclopentadiene	0.00000136	Chlordane	0.00000093		0.00000000
CABT	0.01	0	Lead	0.00000005	Chromium VI	0.00000004	Tetrachloroethylene	0.00000005	Nickel	0.00000005		0.00000000
LTVS	0.01	0	Chromium VI	0.00000500	Nickel	0.00000800	Lead	0.00000020	Copper	0.00000750		0.00000000
ALLD	0.01	0	Arsenic	0.00003760	Dichloromethane	0.00000029	Carbon Tetrachloride	0.00000190	Trichlorofluoromethane	0.00000160	Chloroform	0.00000039

Exhibit A-3

INHALATION UNIT HEALTH SCORES [1/[ug/cu.meter]] AND THRESHOLDS (ug/cu.meter)

POLLUTANT	CANCER UNIT RISK SCORE	CANCER THRESH.	MUTA. UNIT RISK SCORE	MUTA. THRESH.	RENAL UNIT RISK SCORE	RENAL THRESH.	TERATO. UNIT RISK SCORE	TERATO. THRESH.	MALE REPRO. UNIT RISK SCORE	MALE REPRO. THRESH.	FEMALE REPRO. UNIT RISK SCORE	FEMALE REPRO. THRESH.	HEPATIC UNIT RISK SCORE	HEPATIC THRESH.	NEUROLOGIC UNIT RISK SCORE	NEURO. THRESH.	OTHER EFF. UNIT RISK SCORE	OTHER EFFECTS THRESH.
Acrylonitrile	0.0000680000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0
Aldrin	0.0032700000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	61.2	0.0046300000	13.3
Arsenic	0.0042900000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000410000	13.3	0.0000000000	0.0
Benzene	0.0000083000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000046230	2.5
Benzo(A)pyrene	0.0032900000	0	0.00	0.00	0.0000000000	0.0	0.0000014300	0.0	0.0000051500	0.0	0.0000051500	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0
Beryllium	0.0007400000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0
Bromoform	0.0000230000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0014900000	21.0	0.0000000000	0.0	0.0000102000	21.0
Cadmium	0.0018000000	0	0.00	0.00	0.0059000000	0.2	0.0000721000	21.0	0.0000089800	119.0	0.0000089800	119.0	0.0000000000	0.4	0.0000000000	0.0	0.0000000000	2.0
Carbon Tetrachloride	0.0000150000	0	0.00	0.00	0.0000000000	100.0	0.0000006120	24.2	0.0000000000	430.0	0.0000000000	0.0	0.0000260000	2.4	0.0002090000	2.4	0.0000000000	0.0
Chloroform	0.0000230000	0	0.00	0.00	0.0000093600	22.5	0.0000100000	2.4	0.0000030000	2.4	0.0000030000	2.4	0.0000352000	8.5	0.0000760000	11.7	0.0000000000	0.0
Chromium VI	0.0117000000	0	0.00	0.00	0.0000000000	0.0	0.0000014400	7.3	0.0000000000	0.0	0.0000000000	0.0	0.0007460000	7.3	0.0000000000	0.0	0.0321000000	7.3
Bi(2-ethylhexyl)phthalat	0.0000001370	0	0.00	0.00	0.0000000000	2100.0	0.0000002230	245000.0	0.0000005030	245000.0	0.0000005030	245000.0	0.0000000000	2100.0	0.0000000000	0.0	0.0000000000	0.0
Dichlorobenzene, m-	0.0000004000	0	0.00	0.00	0.0000004800	315.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	315.0	0.0000054100	315.0
Dichlorobenzene,o-	0.0000004000	0	0.00	0.00	0.0000004800	315.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	315.0	0.0000054100	315.0
Dichlorobenzene,p-	0.0000004000	0	0.00	0.00	0.0000004800	315.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	315.0	0.0000054100	315.0
Dichloroethane, 1-2-	0.0000066000	0	0.00	0.00	0.0000000000	26.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0002500000	26.0	0.0001700000	26.0	0.0000000000	26.0
Dichloromethane	0.0000041000	0	0.00	0.00	0.0000001920	699.0	0.0000004650	210.0	0.0000000000	0.0	0.0000000000	0.0	0.0000607000	210.0	0.0000000000	8600.0	0.0000009700	8600.0
Dichloropropane,1-2-	0.0000181000	0	0.00	0.00	0.0000001440	308.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000001440	308.0	0.0000000000	0.0	0.0000000000	0.0
Ethylene Dibromide	0.0002170000	0	0.00	0.00	0.0000134000	12.8	0.0000000000	0.0	0.0000112000	1.8	0.0000055900	11.9	0.0000076600	12.8	0.0000000000	0.0	0.0000663000	944.0
Ethylene Oxide	0.0001000000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0
Heptachlor	0.0009600000	0	0.00	0.00	0.0000000000	0.0	0.0000028000	0.3	0.0000000000	0.3	0.0000000000	0.3	0.0002500000	0.3	0.0000000000	0.0	0.0000000000	0.0
Lindane	0.0003100000	0	0.00	0.00	0.0000000000	0.0	0.0000053000	1.1	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	1.1	0.0000000000	1.1	0.0000000000	1.1
Mercury	0.0000000000	0	0.00	0.00	0.0000000000	0.0	0.0000572000	1.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0025000000	1.0	0.0000000000	0.0
Nickel	0.0006000000	0	0.00	0.00	0.0000000000	0.0	0.0026500000	3.5	0.0000372000	3.5	0.0000372000	3.5	0.0000000000	0.0	0.0000000000	0.0	0.0359000000	3.5
PCB	0.0009500000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0
Selenium	0.0000000000	0	0.00	0.00	0.0000000000	10.5	0.0000793000	10.5	0.0000000000	10.5	0.0000000000	10.5	0.0000000000	10.5	0.0000000000	10.5	0.0000000000	0.0
Tetrachloroethylene	0.0000004800	0	0.00	0.00	0.0000009500	69.9	0.0000000000	909.0	0.0000000000	0.0	0.0000000000	0.0	0.0000219000	69.9	0.0000000000	0.0	0.0000000000	0.0
Toluene	0.0000000000	0	0.00	0.00	0.0000000000	1010.0	0.0000005750	476.0	0.0000066400	500.0	0.0000000000	0.0	0.0000000000	1010.0	0.0000134000	500.0	0.0000000000	1010.0
Trichloroethane,1-1-1-	0.0000004580	0	0.00	0.00	0.0000000000	0.0	0.0000599000	16.3	0.0000000000	0.0	0.0000000000	0.0	0.0000001820	97.9	0.0000000000	65500.0	0.0000000000	1050.0
Trichloroethane,1-1-2-	0.0000004580	0	0.00	0.00	0.0000000000	0.0	0.0000599000	16.3	0.0000000000	0.0	0.0000000000	0.0	0.0000001820	97.9	0.0000000000	0.0	0.0000000000	0.0
Trichloroethylene	0.0000013000	0	0.00	0.00	0.0000000000	3770.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	25.9	0.0000102000	25.9	0.0000000000	0.0
Vinyl Chloride	0.0000026000	0	0.00	0.00	0.0000000000	0.0	0.0000000787	161.0	0.0000000295	164.0	0.0000000295	164.0	0.0000005160	69.2	0.0000003800	24.6	0.0000017300	24.6
Xylene,m-,p-,o-	0.0000000000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000009350	52.8	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	215.0

Exhibit A-3

INGESTION UNIT HEALTH SCORES
[1/(ug/l)]
AND THRESHOLDS
(ug/l)

POLLUTANT	CANCER UNIT RISK SCORE	CANCER THRESH.	MUTA. UNIT RISK SCORE	MUTA. THRESH.	RENAL UNIT RISK SCORE	RENAL THRESH.	TERATO. UNIT RISK SCORE	TERATO. THRESH.	MALE REPRO. UNIT RISK SCORE	MALE REPRO. THRESH.	FEMALE REPRO. UNIT RISK SCORE	FEMALE REPRO. THRESH.	HEPATIC UNIT RISK SCORE	HEPATIC THRESH.	NEUROLOGIC UNIT RISK SCORE	NEURO. THRESH.	OTHER EFF. UNIT RISK SCORE	OTHER EFFECTS THRESH.
Acrylonitrile	0.0000150000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.
Aldrin	0.0003270000	0	0.00	0.00	0.0000000000	0.0	0.0000002510	9.1	0.0000000000	4300.0	0.0000000000	4300.0	0.0000202000	9.1	0.0000000000	0.0	0.0017300000	133.
Arsenic	0.0004280000	0	0.00	0.00	0.0000000000	0.0	0.0000000071	133.0	0.0000000334	133.0	0.0000000334	133.0	0.0005330000	133.0	0.0002860000	133.0	0.0000000000	0.
Benzene	0.0000000300	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000423	24.
Benzo(A)anthracene	0.0000769000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.
Benzo(A)pyrene	0.0003290000	0	0.00	0.00	0.0000000000	0.0	0.0000001430	0.0	0.0000005140	0.0	0.0000005140	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.
Bromoform	0.0000023000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0001490000	210.0	0.0000000000	0.0	0.0000010200	210.
Butanol,1-	0.0002400000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	131000.0	0.0000000000	131000.0	0.0000009140	17.5	0.0000009710	17.5	0.0000000000	0.
Cadmium	0.0000000000	0	0.00	0.00	0.0001430000	17.5	0.0000017300	874.0	0.0000001020	4900.0	0.0000001020	4900.0	0.0000000000	17.5	0.0000000000	0.0	0.0000000000	0.
Carbon Tetrachloride	0.0000037000	0	0.00	0.00	0.0000000000	1000.0	0.0000000612	242.0	0.0000000000	4300.0	0.0000000000	0.0	0.0000026000	24.0	0.0000289000	24.0	0.0000000000	0.
Chlordane	0.0000460000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000020200	52500.0	0.0000020200	52500.0	0.0000000400	43000.0	0.0000000000	0.0	0.0000000000	201.
Chloroform	0.0000023000	0	0.00	0.00	0.0000009360	225.0	0.0000001010	795.0	0.0000000000	0.0	0.0000000000	0.0	0.0000035200	85.0	0.0000076000	117.0	0.0000000000	0.
Chromium VI	0.0000000000	0	0.00	0.00	0.0000000000	0.0	0.0000001430	73.4	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.
Bis(2-ethylhexyl)phthalat	0.0000002600	0	0.00	0.00	0.0000000000	21000.0	0.0000000223	2450000	0.0000000503	2450000	0.0000000503	2450000	0.0000000000	21000.0	0.0000000000	0.0	0.0000001140	21000.
Dichlorobenzene, m-	0.0000000400	0	0.00	0.00	0.0000000480	3150.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	3150.0	0.0000005410	3150.
Dichlorobenzene,o-	0.0000000400	0	0.00	0.00	0.0000000480	3150.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	3150.0	0.0000005410	3150.
Dichlorobenzene,p-	0.0000000400	0	0.00	0.00	0.0000000480	3150.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	3150.0	0.0000005410	3150.
Dichloroethane, 1-2-	0.0000020000	0	0.00	0.00	0.0000000000	260.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000250000	260.0	0.0000170000	260.0	0.0000000000	260.
Dichloromethane	0.0000002100	0	0.00	0.00	0.0000000192	6990.0	0.0000000465	2100.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000700	2100.0	0.0000000000	86000.0	0.0000004970	86000.
Dichloropropane,1-2-	0.0000018100	0	0.00	0.00	0.0000000144	3080.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000144	3000.0	0.0000000000	0.0	0.0000000360	3000.
Ethylene Dibromide	0.0011700000	0	0.00	0.00	0.0000013400	128.0	0.0000000000	0.0	0.0000000092	17.5	0.0000005590	119.0	0.0000004000	626.0	0.0000000000	0.0	0.0000000000	0.
Ethylene Oxide	0.0000100000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.
Heptachlor	0.0000960000	0	0.00	0.00	0.0000000000	0.0	0.0000002800	2.8	0.0000000000	2.8	0.0000000000	2.8	0.0000250000	2.8	0.0000000000	0.0	0.0000000000	0.
Lindane	0.0000310000	0	0.00	0.00	0.0000000000	0.0	0.0000005300	1.1	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	1.1	0.0000000000	1.1	0.0000000000	1.
Mercury	0.0000000000	0	0.00	0.00	0.0000000000	0.0	0.0007130000	10.1	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0003130000	10.1	0.0000000000	0.
Nickel	0.0000000000	0	0.00	0.00	0.0000000000	0.0	0.0000265000	350.0	0.0000003720	350.0	0.0000003720	350.0	0.0000000000	0.0	0.0000000000	0.0	0.0000150000	350.
PCB	0.0001240000	0	0.00	0.00	0.0000763000	10.5	0.0000000000	0.0	0.0001070000	10.5	0.0001070000	10.5	0.0000016000	10.5	0.0001310000	10.5	0.0003590000	10.
Selenium	0.0000000000	0	0.00	0.00	0.0000000000	105.0	0.0000079300	105.0	0.0000000000	105.0	0.0000000000	105.0	0.0000000000	105.0	0.0000000000	105.0	0.0000000000	105.
Tetrachloroethylene	0.0000015000	0	0.00	0.00	0.0000000950	699.0	0.0000000000	9090.0	0.0000000000	0.0	0.0000000000	0.0	0.0000021900	699.0	0.0000000000	0.0	0.0000000000	0.
Toluene	0.0000000000	0	0.00	0.00	0.0000000000	10100.0	0.0000000575	4760.0	0.0000006640	5000.0	0.0000000000	0.0	0.0000000000	10100.0	0.0000013400	5000.0	0.0000000000	0.
Toxaphene	0.0000322000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	131000.0	0.0000000000	0.0	0.0000000000	43.7	0.0000000000	0.0	0.0000000000	0.
Trichloroethane,1-1-1-	0.0000000458	0	0.00	0.00	0.0000000000	0.0	0.0000200000	49.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000467	979.0	0.0000000000	12500.0	0.0000000000	0.
Trichloroethane,1-1-2-	0.0000000458	0	0.00	0.00	0.0000000000	0.0	0.0000200000	49.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000467	979.0	0.0000000000	0.0	0.0000000000	0.
Trichloroethylene	0.0000003150	0	0.00	0.00	0.0000000000	37700.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	259.0	0.0000010200	259.0	0.0000000000	0.
Vinyl Chloride	0.0000660000	0	0.00	0.00	0.0000000000	0.0	0.0000000079	1640.0	0.0000000029	1640.0	0.0000000029	1640.0	0.0000067800	65.5	0.0000000380	246.0	0.0000000992	246.
Xylene,m-,p-,o-	0.0000000000	0	0.00	0.00	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000955	528.0	0.0000000000	0.0	0.0000000000	0.0	0.0000000000	2150.

Exhibit A-4

POLLUTANTS WITHOUT HEALTH SCORES

POLLUTANT

1-(o-chlorophenyl)thiour
1-chloro-2,3-epoxypropan
2,4-D
2-Hydroxy-2-methyl Propa
5-(Aminomethyl)-3-Isoxaz
5-Nitro-o-toluidine
Acenaphthene
Acetaldehyde
Acetone
Acetonitrile
Acetophenone
Acetyl Chloride
Acetylaminofluorene,2-
Acrolein
Acrylamide
Acrylic Acid
Aldicarb
Allyl Alcohol
Aluminum Phosphide
Amino-anthraquinone,2-
Ammonium Picrate
Aniline
Arsenic Acid
Arsenic Pentoxide
Arsenic Trioxide
Asbestos
Barium
Benz[c]acridine
Benzalchloride
Benzenesulfonyl Chloride
Benzidine
Benzo(b)fluoranthene
Benzoquinone,p-
Benzyl Chloride
Bis(chloromethyl)ether
Bromine Cyanide
Bromoacetone
Calcium Chromate
Calcium Cyanide
Carbamimidoselenoic Acid
Carbon Disulfide
Carbonyl Chloride
Chloracetaldehyde
Chlorambucil
Chloroaniline, p-,o-,m-
Chlorobenzene
Chloromethane
Chloronapthalene,B-
Chlorophenol,o-

Exhibit A-4

(Continued)

POLLUTANT

Chrysene
Copper
Copper Cyanide
Creosote
Cresols
Crotonaldehyde
Cumene
Cyanides NOS
Cyclohexane
Cyclohexanone
DDD
DDT
Di-N-octyl Phthalate
Dibenzo(1,2
5,6)anthrace
Dibromo-3-chloropropane,
Dibutyl Phthalate
Dichlorobenzidene, 3-3'-
Dichlorodifluoromethane
Dichloroethyl Ether
Dichloroethylene, 1-1-
Dichloroethylene, 1-2-
Dichlorophenol, 2-6-
Dichlorophenol,2-4-
Dieldrin
Diethyl Phthlate
Diethyl-p-nitrophenyl ph
Diisopropyl Fluorophosph
Dimethoate
Dimethyl Phthalate
Dimethyl Sulfate
Dimethylamine
Dimethylhydrazine, 1-2-
Dimethylhydrazine,1-1-
Dimethylnitrosamine
Dinitro-o-cresol, 4-6-
Dinitro-o-cresol, 4-6-
Dinitrophenol,2-4-
Dinitrotoluene, 2-4-
Dinitrotoluene, 2-6-
Dinoseb
Dioxane,1-4-
Diphenyl Hydrazine, 1-2-
Disulfoton
Edothall
Endosulfan
Endrin
Ethyl Acetate
Ethyl Acrylate

POLLUTANT

Ethyl Carbamate
Ethyl Ether
Ethylene Diamine
Ethylene Thiourea
Ethylenebis(dithiocarbam
Ethylmethacrylate
Ethylmethanesulfonate
Fluoracetamide,2-
Fluoranthene
Formaldehyde
Formic Acid
Fufural
Furancarboxaldehyde, 2-
Glycidylaldehyde
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclohexane
Hexachlorocyclopentadien
Hexachloroethane
Hexachlorophene
Hydrazine
Hydrocyanic Acid
Hydrogen Sulfide
Hydrogen flouride
Hydroxydimethylarsine
Indeno(1-2-3-cd)pyrene
Isobutyl Alcohol
Lead Acetate
Lead Phosphate
Maleic Anhydride
Maleic Hydrazide
Methane, iodo-
Methanol
Methomyl
Methoxychlor
Methyl Chlorocarbonate
Methyl Ethyl Ketone
Methyl Ethyl Ketone Pero
Methyl Hydrazine
Methyl Isobutyl Ketone
Methyl Isocyanate
Methyl Methacrylate
Methyl Parathion
Methylenebis(2-chloroani
Methythiouracil
N-(aminothioxomethyl)ace
N-Nitroso-N_methylurea
Naphthylamine,2-
Napthalene

Exhibit A-4

(Continued)

POLLUTANT

Napthoquinone,1-4-
Nickel Carbonyl
Nicotine And salts (can'
Nitric Oxide
Nitroaniline,p-
Nitrobenzene
Nitrogen Dioxide
Nitroglycerine
Nitrophenol,p-
Nitropropane,2-
Nitrosodiethanolamine,n-
O,O-Diethyl O-pyrazinyl
O,O-Diethyl-S-methyl-dit
Osmium Tetroxide
Parathion
Pentachloroethane
Pentachloronitrobenzene
Pentachlorophenol
Pentadiene,1-3-
Phenacetin
Phenol
Phenylmercuric Acetate
Phorate
Phthalic Anhydride
Picoline,2-
Potassium Cyanide
Potassium Silver Cyanide
Propane Nitrile
Propanediol,1-2-
Propargyl alcohol
Propylamine,n-
Pyradinamine,4-
Pyridine
Resorcinol
Selenious Acid
Selenium Disulfide
Silver
Silver Cyanide
Silvex, 2,4,5-TP
Sodium Azide
Sodium Cyanide
Strychnine and Salts
Tetrachlorobenzene,1-2-4
Tetrachloroethane,1-1-1-
Tetrachloroethane,1-1-2-
Tetraethyl Lead
Tetrahydrofuran
Thallium Chloride
Thallium Sulfate

Exhibit A-4

(Continued)

POLLUTANT

Thioacetamide
Thiofanox
Thiophenol
Thiourea
Thiram
Toluene Hydrochloride,o-
Toluene-2,4-Diisocyanate
Toluene-2,4-diamene
Trichlorobenzene,1-2-4-
Trichlorofluoromethane
Trichloromethanethiol
Trichlorophenol, 2-4-5-
Trichlorophenoxyacetic A
Trinitrobenzene, sym-
Trinitrotoluene,2-4-6-
Tris(2,3-dibromopropyl)p
Trypan Blue
Uracil Mustard
Vanadic Acid
Vanadium Pentoxide
Warfarin
Zinc Cyanide
Zinc Phosphide
Acenaphthalene
Benzotrichloride
Methapyrilene
2-Picoline

Exhibit A-5

UNIT COSTS BY MANAGEMENT METHODS

	Small On-Site	Large On-Site	Small Off-Site	Large Off-Site
Drum and Tank Storage	$0.40/gal	$ 0.40/gal	$ 0.40/gal	$ 0.40/gal
Surface Impoundment	4.16/gal	0.39/gal	0.39/gal	0.39/gal
Waste Pile	$726/m ton	$51.62/m ton	$51.62/m ton	$51.62/m ton
Liquid Injection Incineration	200/m ton	100/m ton	200/m ton	100/m ton
Rotary Kiln Incineration	300/m ton	150/m ton	300/m ton	150/m ton
pH Adjustment	$2.20/gal	$ 1.10/gal	$ 1.10/gal	$ 1.10/gal
Distillation	2.29/gal	2.29/gal	1.10/gal	1.10/gal
Stabilization/Fixation	0.81/gal	0.74/gal	0.74/gal	0.74/gal
Biological Treatment	1.05/gal	0.63/gal	1.10/gal	1.10/gal
Underground Injection	$290/m ton	$145/m ton	$145/m ton	$145/m ton
Landfill	517/m ton	50/m ton	200/m ton	175/m ton

Exhibit A-6

SIDE DEFINITIONS BY MANAGEMENT STRATEGY

	Small	Large
Drum and Tank Storage	N/A	N/A
Surface Impoundment	24,436 gal/yr	811 gal/yr
Waste Pile	72 m-tons	3,400 m-tons
Liquid Injection Incineration	<5,000 BTU/lb	≤5,000 BTU/lb
Rotary Kiln Incineration	<5,000 BTU/lb	≤5,000 BTU/lb
pH Adjustment	<480 gal/day	>480 gal/day
Distillation	N/A	N/A
Stabilization/Fixation	<200 gal/day	>200 gal/day
Biological Treatment	1 MGD	5 MGD
Underground Injection	N/A	N/A
Landfill	500 MT/yr	60,000 MT/yr

Appendix B

CLUSTER AND ENVIRONMENT DESCRIPTIONS

Exhibit B-1

AIR ENVIRONMENT DESCRIPTION

<u>METEOROLOGY</u>

-- One canonical environment: afternoon mixing height 1200 meters, average ambient temperature 280 degrees Kelvin.

Exhibit B-2

SURFACE WATER ENVIRONMENTS

SURFACE WATER

--Small Coldwater Stream. Low flow less than 100 cubic feet per second, mean total suspended solids greater than 100 mg/l, minimum temperature than 25 degrees Celsius.

--Medium Coldwater Stream. Low flow between 100 and 1,000 cubic feet per second, mean total suspended solids greater than 100 mg/l, minimum temperature less than 25 degrees Celsius.

--Large Coldwater Stream. Low flow greater than 1,000 cubic feet per second, mean total suspended solids less than 25 mg/l, minimum temperature less than 25 degrees Celsius.

Exhibit B-3

GROUND WATER ENVIRONMENTS

On the Assignment of Hydrogeologic Settings and Flow Fields to Clusters

Stratis G. Vomvoris

The state of Illinois has a very strong and active Geological Survey and extensive studies of the subsurface water activities have been undertaken (a small sample was provided for this study). Unfortunately, most of these publications, being State Survey ones, can not be found easily in libraries outside the state of Illinois. Based on the references provided by Ms. Hulse, Walton's book and a few references found in our library the following questions were asked in order to assign hydrogeologic setting(s) to a cluster:

(a) How many aquifers were present?
(b) Are they shallow or deep?
(c) If multiple aquifers, which is the primary one and what is the direction of the leakage?

The detailed information about some of the sites shows that there is a tremendous variability and ,therefore, the generalization of the characteristics of a local system to the size of a cluster could be questionable. The results should be used with a lot of caution.

In terms of velocity characterization I could not find much information on head gradients. Natural gradients do not exist in most places since the Illinois groundwater system is extensively developed. The velocity fields chosen are more or less educated guesses.

For some of the work you are doing you might want to study further the information in Reference 3 [Berg et al, 1984]. As a concluding remark let me mention that the results should be used with extreme caution and be considered as preliminary indications of what might be happening at a specific cluster.

Exhibit B-3

(Continued)

ILLINOIS

Cluster	Hydrogeologic Setting	Flow Field	Ref
1	1,2,7,8	C,D,E,I	1
2	1,2,7,8	C,D,E,I	1
3	3,4,8	F,I	1,5
4	3,4,8	F,I	1,5
5	3,4,7,8	B,C,F,I	1,6
6	3,4,8	B,C,F,I	1,5
7	3,4,7,8	B,C,F,I	1,6
8	3,4,8	B,C,F,I	1
9	1,2,7,8	C,D,E,I	1
10	1,2,7,8	C,D,E,I	1
11	3,4,7,8	F,I	2
12	3,4,7,8	F,I	2
13	3,4,7,8	F,I	2
14	3,4,7,8	F,I	2
15	1,2,3,4	B,C,D,E,F	3
16	1,2	A,B,C,D,E	2
17	3,4,7,8	F,I	2
18	1,2,7,8	C,D,E,I	1
19	1,2,7,8	C,D,E,I	1
20	2	A,B,C	1
21	1,2,3,4	A,B,C,D,E	100
22	1,2	A,B,C,D,E	1
23	3,4,8	F,I	1
24	1,2,3,4	A,B,C,D,E,F	100
25	3,4	F	1
26	1,2,3,4	A,B,C,D,E,F	100
27	1,2,3,4	A,B,C,D,E,F	100
28	1,2,3,4	A,B,C,D,E,F	100
29	1,2,3,4	A,B,C,D,E,F	2,101
30	1,2,3,4	A,B,C,D,E,F	2,101
31	1,2,3,4	A,B,C,D,E,F	2,101
32	3	F	1
33	1,4	B,C,D,E,F	1
34	1,2	B,C,D,E	2
35	3,4	F	2
36	1,4	B,D,E,F	1
37	1,2,3,4	B,D,E,F	2
38	3,4	A,F	2
39	3,4	F	100
40	3,4	[illegible]	100
41	3,4	F	100
42	3,4	F	2
43	1,2	B,C,D,E	100
44	1,2	B,C,D,E	100
45	1,2,3,4	B,C,D,E,F	100
46	3,4	F	1
47	1,2	B,C,D,E	1,7
48	1,2	B,C,D,E	1,7
49	1,2	B,C,D,E	1,7
50	3,4	F	2,1
51	1,2	A,B,C	1

Exhibit B-3

(Continued)

52	1,2	A,B,C	100
53	1,2	B,C,D,E	1
54	1,2	B,C,D,E	1
55	1,2	B,C,D,E	1
56	3,4	F	1
57	1,2	A,B,C,D	1
58	1,2	B,C,D,E,	1
59	1,2	A,B,C,D,E	1,3
60	1,2	A,B,C,D,E	1,3
61	1,2	A,B,C,D,E	1,3
62	3,4	F	1
63	3,4	F	1
64	1,2	B,C,D,E	1
65	1,2	B,C,D,E	1
66	1,2	B,C,D,E	100
67	1,2	B,C,D,E	100
68	1,2	A,B,C,D,E	100
69	1,2	A,B,C,D,E	100
70	1,2	A,B,C,D,E	100
71	1,2	A,B,C,D,E	100
72	1,2	A,B,C,D,E	100
73	1	B,C,D,E	1
74	1,2	A,B,C,D,E	8
75	1,2,3,4	B,C,D,E,F	100

The LLM input that required development for each groundwater region included the following:

- o Depth to groundwater
- o Net groundwater recharge
- o Applicable generic flow fields (nine flow fields exist in LLM)
- o Depth of target wells
- o Distance to target wells from source.

The depth of the target well is set by the LLM code based on other hydrologic characteristics. The distance to a target well was arbitrarily selected to be a constant 600 meters for all LLM runs. The only exception to this well distance was for septic tanks. For this category, all well distances in the model (60m, 600m, and 1600m) were used because of the close spacing of tanks at the high density subcategory. Modeling all three distances for septic tanks allows for better estimates of exposure.

Depth to groundwater and net groundwater recharge for each region were assigned based on ranges of values developed by the National Water Well Association (NWWA) draft report entitled "A Standard System for Evaluating Groundwater Pollution Potential Using Hydrogeologic Settings" (1984). Using this data, an average range of values for depth to groundwater and net groundwater recharge were assigned. The mid-point of the range was selected as the value to be modeled and representative of each range (EPA, Sobotka and Company, Inc., and JRB Associates). These ranges and mid-points are given in Table 1-4. Region 12-Alluvial Valleys has been incoporated into each region because this is the form data was required for analysis and LLM input.

Nine generic flow fields exist within the present LLM code to represent all possible groundwater hydraulic conditions in the conterminous United States. The nine flow fields (A through I) used in the LLM are greatly simplified descriptions of two-dimensional groundwater flow conditions. Figure 1-2

Source: JRB (1984).

Exhibit B-3

(Continued)

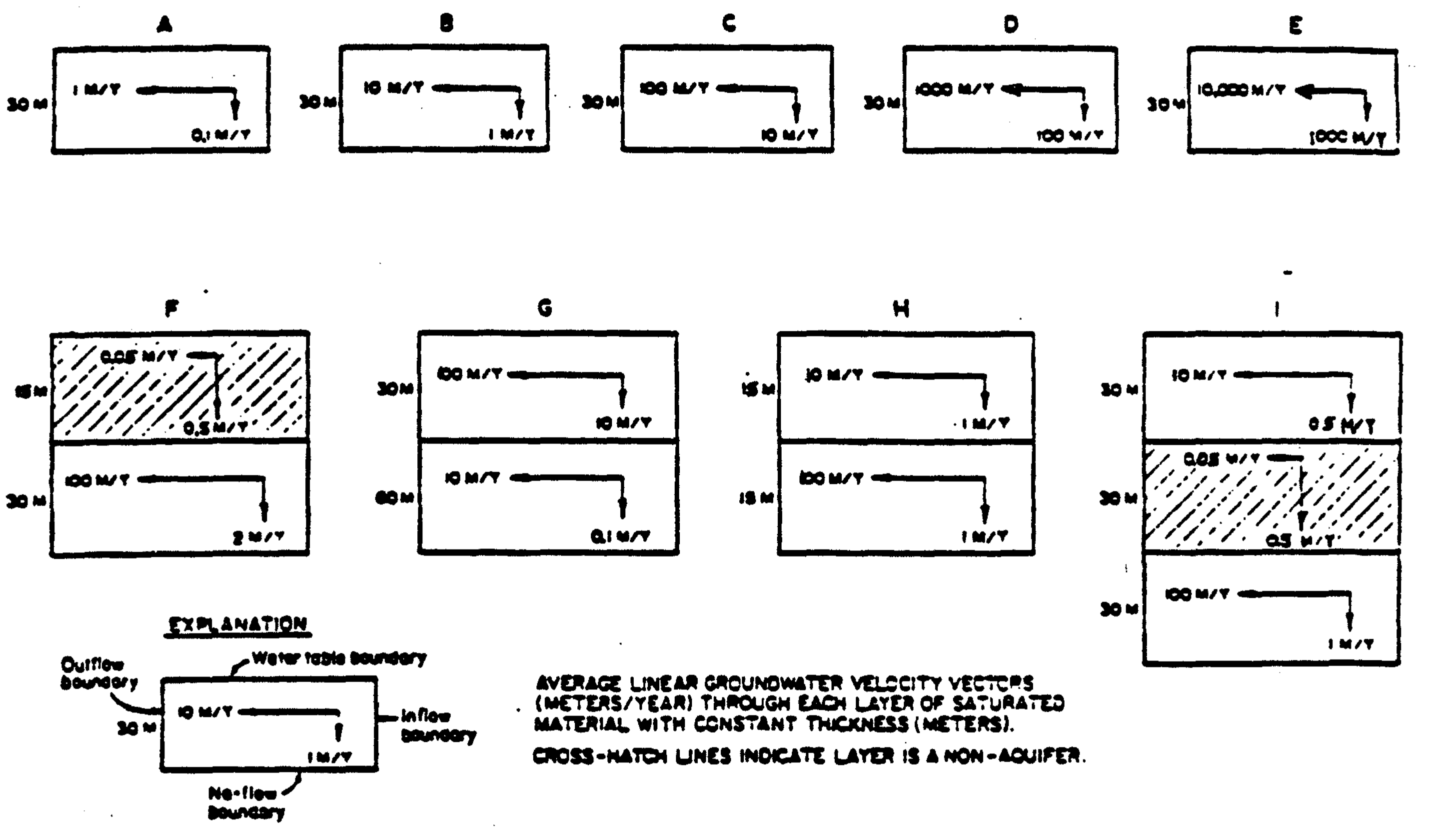


Figure 1-2. Flow Fields in LLM Code
(Geraghty & Miller, Inc., 1984)

Source: JRB (1984).

illustrates the flow fields. Flow conditions in each field are described by:

- Horizontal flow velocity
- Vertical flow velocity
- Thickness of aquifer and non-aquifer units
- Arrangement of aquifer and non-aquifer units.

The nine flow fields were developed by Geraghty & Miller, Inc. (1984) for the original LLM based on published groundwater modeling studies and their best professional judgement.

Using data collected by Geraghty & Miller, Inc. (1984) in the initial study, flow fields were able to be assigned to 10 of the 12 groundwater regions. Flow fields were assigned to the two remaining groundwater regions (Region 4 - Colorado Plateau and Wyoming Basin and Region 5 - High Plains) based on available published data in Heath (1984), McGuinness (1963), NWWA (1984), and Geraghty & Miller, Inc. (1984), and the best professional judgements of JRB. Actual data from groundwater studies performed in these groundwater regions was not obtained and would be required for a better characterization. Assigned flow fields utilized in the study are given in Table 1-4.

Source: JRB (1984).

Exhibit B-3

(Continued)

TABLE 1-4. DEPTH TO GROUNDWATER AND NET GROUNDWATER RECHARGE (ADAPTED FROM NWWA, 1984)

Groundwater Region*	Depth to Groundwater (m) Range	Depth to Groundwater (m) Midpoint	Net Recharge (in) Range	Net Recharge (in) Midpoint	Dominant Aquifer Type	Flow Fields (Geraghty & Miller, 1984)
1-Western Mountain Ranges						
NV	15.2-30.5	22.9	0-2	1.0	fractured bedrock	B,C,F,H,
AV	3.0-9.1	6.1	2-5	3.5	sand and gravel	C,D,G,I
2-Alluvial Basins						
NV	15.2-30.5	22.9	0-2	1.0	fractured bedrock	A,B,C,D,E,F,G,H,I
AV	15.2-30.5	22.9	0-2	1.0	sand and gravel	C,D,G,I
3-Columbia Lava Plateau						
NV	15.2-30.5	22.9	2-5	3.5	fractured bedrock/basalt	B,C,D,G,H
AV	3.0-9.1	6.1	2-5	3.5	sand and gravel	C,D,G,I
4-Colorado Plateau and Wyoming Basin						
NV	15.2-30.5	22.9	0-2	1.0	fractured bedrock	A,B,C,D,E,F,G,H,I
AV	3.0-9.1	6.1	2-5	3.5	sand and gravel	C,D,G,I
5-High Plains						
NV	15.2-30.5	22.9	0-2	1.0	sand and gravel	A,B,C,D,E,F,G,H,I
AV	0.0-3.0	1.5	5-10	7.5	sand and gravel	C,D,G,I
6-Nonglaciated Central						
NV	9.1-15.2	12.2	5-10	7.5	fractured bedrock/karst	A,B,E,F,I
AV	3.0-9.1	6.1	5-10	7.5	sand and gravel	C,D,G,I
7-Glaciated Central						
NV	9.1-15.2	12.2	5-10	7.5	fractured bedrock/ karst/s&g	A,B,C,F,G,I
AV	3.0-9.1	6.1	5-10	7.5	sand and gravel	C,D,G,I
8-Piedmont and Blue Ridge						
NV	9.1-15.2	12.2	5-10	7.5	fractured bedrock/regolith	A,B,F
AV	3.0-9.1	6.1	5-10	7.5	sand and gravel	C,D,G,I
9-Northeast and Superior Uplands						
NV	9.1-15.2	12.2	5-10	7.5	fractured bedrock/s&g	B,C,F,G
AV	3.0-9.1	6.1	5-10	7.5	sand and gravel	C,D,G,I
10-Atlantic Gulf and Coastal Plain						
NV	3.0-9.1	6.1	5-10	7.5	sand and gravel	A,B,C,F,G,H,I
AV	0.0-3.0	1.5	5-10	7.5	sand and gravel	C,D,G,I
11-Southeast Coastal Plain						
NV	3.0-9.1	6.1	10+	15	karst/carbonates	B,C,D,F,I
Swamps	0.0-3.0	1.5	10+	15	karst	A,B,C,D,E,F,G,H,

*NV = Non-Valley Areas; AV = Alluvial Valley Areas

Source: JRB (1984).

1.4 LLM LIMITATIONS

Numerous limitations are inherent in the LLM code which restrict its range of application for the source categories chosen in this study. Some of these limitations include the model's inability to model fracture flow, three dimensional flow and contaminant transport, and immiscible compounds. Table 1-6 lists the major limitations with the existing model for use in this effort. Also provided are possible solutions or modifications to the model that may make it more applicable to this effort and future efforts.

Outlines of the LLM flow codes were also developed to determine the assumptions used in model development and limitations inherent in the code's use. Tables 1-7 and 1-8 provide outlines for both the unsaturated and saturated models, respectively. In general, the LLM code provides for modeling only the simplest hydrogeologic settings and geochemical reactions.

In summary, the major limitations that should be recognized by uses of the data output from the LLM are:

- o The model assumes that groundwater flow occurs as a result of primary porosity (i.e., not through fractures or other openings). Only 30% (approximately) of the dominant aquifers in the U.S. can be assumed to be represented by this type of flow (Figure 1-3).

- o The model assumes that the unsaturated and saturated zone are homogeneous, isotropic mediums. In reality most earth materials are neither homogeneous or isotropic.

- o The model does not handle immiscible contaminants such as gasoline. These chemicals may move as plugs through the aquifer at rates different than groundwater flow rates.

Source: JRB (1984).

Exhibit B-3

(Continued)

- Attenuation mechanisms such as retardation, dispersion, and degradation are simplified in the model. Simplification can cause results to be erroneous.

- The model does not handle multiple sources or intermittent loading of contaminants. Both of these problems can lead to erroneous results.

- The interaction among various chemicals is not accounted for in the transport code.

- The accuracy of the model is possibly plus and minus one order of magnitude. Validation testing of codes has not been performed.

Source: JRB (1984).

Exhibit B-3

(Continued)

TABLE B-1
BRIEF DESCRIPTIONS OF GENERIC HYDROGEOLOGIC SUBREGIONS

USGS Region Number	Generic Subregion Number	General Hydrogeology	General Climate
1	1A	Alluvial basin fill aquifer[a]	Temperate[b]
	1B	Undifferentiated bedrock	Alpine; humid to temperate
	1C	Undifferentiated bedrock aquifer	Temperate
2	2A*	Alluvial basin fill aquifer	Humid
	2A	Alluvial basin fill aquifer	Temperate to arid
	2B	Undifferentiated bedrock	Semi-arid to arid
3	3A	Alluvial aquifer over basalt aquifer	Semi-arid to arid
	3B	Basalt aquifers	Semi-arid to arid
	3C	Undifferentiated bedrock	Temperate to semi-arid
4	4A	Alluvial fill aquifer	Semi-arid
	4B	Undifferentiated bedrock	Semi-arid
	4C	Carbonate aquifers	Semi-arid
5	5A	Poor consolidated sandstone aquifer	Temperate to semi-arid
	5B	Undifferentiated bedrock	Temperate
6	6A	Alluvial aquifer over bedrock	Semi-arid
	6B	Undifferentiated bedrock	Temperate to semi-arid
	6C	Carbonate aquifer	Temperate to semi-arid
	6D	Sandstone aquifer	Temperate to semi-arid
7	7A	Glacial over bedrock aquifer	Temperate
	7B	Glacial drift over undifferentiated bedrock	Temperate to semi-arid
	7C	Glacial drift over limestone aquifer	Temperate
	7D	Glacial drift over sandstone aquifer	Temperate
8	8A	Saprolite aquifer over crystalline bedrock	Temperate to humid
	8B	Residuum over limestone/sandstone aquifer	Temperate to humid
	8C	Crystalline bedrock	Temperate to humid
9	9A	Undifferentiated sand, gravel, sandstone aquifer	Temperate
	9B	Glacial drift over bedrock	Temperate
10	10A	Undifferentiated sand, gravel, sandstone aquifer	Temperate to arid
	10B	Undifferentiated silts, clay, shale bedrock	Temperate
	10C	Carbonate aquifer	Temperate
	10D	Multiple carbonate aquifer	Temperate
11	11	Fluvial/glacial sand - gravel aquifer near perennial streams	Temperate to semi-arid

[a] Aquifer is defined as being capable of yielding water to continuously discharging well operating at 50 gal/min.

[b] Arid = $\leq$10 in/yr; Semi-arid=10-20 in/yr; Temperate = 20-50 in/yr; Humid $\geq$ 50 in/yr

Source: Geraghty and Miller (1984).

C. Groundwater (Saturated Zone) Transport Model

Geraghty & Miller, Inc., selected the approach, models, and parameter values used for the saturated zone transport analysis. The random-walk particle tracking model of Prickett et al. (1981) was used to simulate transport. A full description of the approach to groundwater modeling is given in Appendix D. Subsurface Transport Modeling.

The groundwater transport model itself was not incorporated into the liner-location risk model. Rather, an input file was constructed from the model output generated by Geraghty & Miller. The liner-location model selects the appropriate value from the input file, then adjusts it as required to give either the groundwater concentration or mass loading rate to a surface water body. The groundwater transport model was run for nine groundwater flow scenarios, three distances (between source and exposure point), and three constituent mobility classes over a 200-year simulation period. The outputs, based on a unit mass input, are groundwater concentration and mass loading rate estimates for 200 years for each scenario-distance-mobility class combination. Groundwater scenario, distance, and constituent identification

Source: ICF (1984).

Exhibit B-3

(Continued)

(which determines mobility) are input variables that must be specified for each model run. Based on these specifications, the liner-location model retrieves the appropriate value.

Retrieval of the correct groundwater concentration or mass loading rate for the four multi-layer groundwater flow scenarios (F, G, H, I) requires an additional step. For the single-layer flow scenarios (A, B, C, D, E), only one value is available for each scenario-distance-mobility class combination, and that value is used. Scenario F, which has an aquifer below a non-aquifer, has values only for the aquifer layer. These values are used in all cases, with the assumption that any well must penetrate the aquifer layer. Scenarios G, H, and I are double-aquifer scenarios, with values for both aquifer layers (scenario I also has an intervening non-aquifer layer). The appropriate layer for well concentrations is determined by comparing the well depth (given in Appendix E for site-visit facilities) with the depth of the boundary between aquifers (sum of unsaturated zone depth and top layer depth and, for Scenario I, half of the intervening layer depth). Mass loadings for scenarios G and H are the sum of the loadings for the two layers. The top layer values only are used to determine mass loadings for Scenario I.

Source: ICF (1984).

Exhibit B-4

ILLINOIS CITIES BY CLUSTER

CLUSTER	CITY
IL01	ZION
IL02	ANTIOCH
IL02	RICHMOND
IL02	RINGWOOD
IL02	ROUND LAKE
IL02	ROUND LAKE BEACH
IL02	SPRING GROVE
IL03	ABBOTT PARK
IL03	ARLINGTON HEIGHTS
IL03	DEERFIELD
IL03	DES PLAINES
IL03	GLENVIEW
IL03	GRAYSLAKE
IL03	GREAT LAKES
IL03	GURNEE
IL03	HIGHLAND PARK
IL03	LAKE BLUFF
IL03	LAKE ZURICH
IL03	LIBERTYVILLE
IL03	MCGAW PARK
IL03	MOUNT PROSPECT
IL03	MT PROSPECT
IL03	MUNDELEIN
IL03	NORTH CHICAGO
IL03	NORTHBROOK
IL03	NORTHFIELD
IL03	PALATINE
IL03	PRAIRIE VIEW
IL03	ROLLING MEADOWS
IL03	VERNON HILLS
IL03	WAUKEGAN
IL03	WHEELING
IL04	ALGONQUIN
IL04	BARRINGTON
IL04	CARPENTERSVILLE
IL04	CARY
IL04	CRYSTAL LAKE
IL04	EAST DUNDEE
IL04	FOX RIVER GROVE
IL04	HAMPSHIRE
IL04	HUNTLEY
IL04	ISLANDLAKE
IL04	MCHENRY
IL04	MCHENRY SHORES
IL04	WOODSTOCK
IL05	ADDISON
IL05	BARTLETT
IL05	BEDFORD PARK
IL05	BELLWOOD

Exhibit B-4
(continued)

IL05	BRIDGEVIEW
IL05	BROADVIEW
IL05	BROOKFIELD
IL05	BURR RIDGE
IL05	CHICAGO
IL05	CICERO
IL05	COUNTRYSIDE
IL05	ELMHURST
IL05	EVANSTON
IL05	EVERGREEN PARK
IL05	FOREST PARK
IL05	FOREST VIEW
IL05	FRANKLIN PARK
IL05	GENEVA
IL05	GLEN ELLYN
IL05	HARWOOD HEIGHTS
IL05	HILLSIDE
IL05	HINSDALE
IL05	HODGKINS
IL05	LA GRANGE
IL05	LA GRANGE PARK
IL05	LAGRANGE
IL05	LINCOLNWOOD
IL05	LYONS
IL05	MAYWOOD
IL05	MCCOOK
IL05	MELROSE PARK
IL05	MORTON GROVE
IL05	NILES
IL05	NORRIDGE
IL05	NORTH RIVERSIDE
IL05	NORTHLAKE
IL05	OAK BROOK
IL05	OAK LAWN
IL05	PARK RIDGE
IL05	RIVER GROVE
IL05	ROSEMONT
IL05	SCHILLER PARK
IL05	SKOKIE
IL05	STICKNEY
IL05	SUMMIT
IL05	WILLOW SPRINGS
IL05	WILLOWBROOK
IL06	AURORA
IL06	BATAVIA
IL06	BENSENVILLE
IL06	CAROL STREAM
IL06	CLARENDON HILLS
IL06	DOWNERS GROVE

Exhibit B-4
(continued)

IL06	ELGIN
IL06	ELK GROVE VILLAGE
IL06	HOFFMAN ESTATES
IL06	ITASCA
IL06	LAFOX
IL06	LISLE
IL06	LOMBARD
IL06	NAPERVILLE
IL06	ROSELLE
IL06	SCHAUMBURG
IL06	SOUTH ELGIN
IL06	ST CHARLES
IL06	STREAMWOOD
IL06	VILLA PARK
IL06	WEST CHICAGO
IL06	WESTMONT
IL06	WHEATON
IL06	WOOD DALE
IL07	ALSIP
IL07	BLUE ISLAND
IL07	BURNHAM
IL07	CALUMET CITY
IL07	CHICAGO HEIGHT
IL07	CHICAGO HEIGHTS
IL07	CHICAGO HTS.
IL07	CRESTWOOD
IL07	CRETE
IL07	DOLTON
IL07	EAST HAZEL CREST
IL07	FRANKFORT
IL07	HARVEY
IL07	LANSING
IL07	MATTESON
IL07	MOKENA
IL07	OAK FOREST
IL07	ORLAND PARK
IL07	PARK FOREST
IL07	PARK FOREST SOUTH
IL07	RIVERDALE
IL07	S CHICAGO HEIGHTS
IL07	SOUTH CHICAGO HIEGHT
IL07	SOUTH HOLLAND
IL07	TINLEY PARK
IL07	UNIVERSITY PARK
IL08	ARGONNE
IL08	BOLINGBROOK
IL08	CHANNAHON
IL08	ELWOOD
IL08	JOLIET

Exhibit B-4
(continued)

IL08	LEMONT
IL08	LOCKPORT
IL08	NEW LENOX
IL08	PLAINFIELD
IL08	ROMEOVILLE
IL09	BELVIDERE
IL09	CAPRON
IL09	GENOA
IL09	HARVARD
IL09	HERBERT
IL09	MARENGO
IL10	LOVES PARK
IL10	ROCKFORD
IL10	ROSCOE
IL10	SOUTH BELOIT
IL10	WINNEBAGO
IL11	FREEPORT
IL11	PECATONICA
IL12	STOCKTON
IL12	WARREN
IL13	GALENA
IL14	SAVANNA
IL15	CORDOVA
IL15	EAST MOLINE
IL15	MOLINE
IL15	PORT BRYON
IL15	PORT BYRON
IL15	ROCK ISLAND
IL16	MORRISON
IL16	PROPHETSTOWN
IL17	DIXON
IL17	POLO
IL17	ROCK FALLS
IL17	STERLING
IL18	BYRON
IL18	MT MORRIS
IL18	OREGON
IL18	ROCHELLE
IL18	STILLMAN VALLEY
IL19	DE KALB
IL19	DEKALB
IL19	SYCAMORE
IL20	MONTGOMERY
IL20	OSWEGO
IL20	SANDWICH
IL20	SUGAR GROVE
IL20	YORKVILLE
IL21	EARLVILLE
IL21	LELAND

Exhibit B-4
(continued)

IL21	MENDOTA
IL21	OTTAWA
IL21	UTICA
IL22	COAL CITY
IL22	MARSEILLES
IL22	MORRIS
IL22	SENECA
IL23	BEECHER
IL23	BOURBONNAIS
IL23	BRADLEY
IL23	KANKAKEE
IL23	MOMENCE
IL23	PEOTONE
IL24	KEWANEE
IL24	SHEFFIELD
IL25	HENNEPIN
IL25	LASALLE
IL25	PERU
IL25	PRINCETON
IL25	SPRING VALLEY
IL26	STREATOR
IL27	DWIGHT
IL27	PONTIAC
IL27	SAUNEMIN
IL28	CHATSWORTH
IL28	COLFAX
IL29	GALESBURG
IL29	MONMOUTH
IL30	GALVA
IL31	CHILLICOTHE
IL31	HENRY
IL31	WYOMING
IL32	EL PASO
IL32	GOODFIELD
IL32	METAMORA
IL32	ROANOKE
IL33	BARTONVILLE
IL33	CREVE COEUR
IL33	EAST PEORIA
IL33	GLASFORD
IL33	MAPLETON
IL33	MORTON
IL33	MOSSVILLE
IL33	NORTH PEKIN
IL33	PEKIN
IL33	PEORIA
IL33	TREMONT
IL34	BLOOMINGTON
IL34	NORMAL

Exhibit B-4
(continued)

IL35	MACOMB
IL36	HAVANA
IL37	ATLANTA
IL37	DELAVAN
IL37	LINCOLN
IL37	UNION
IL38	CLINTON
IL39	CHAMPAIGN
IL39	FISHER
IL39	RANTOUL
IL39	URBANA
IL40	MILFORD
IL40	ONARGA
IL40	WATSEKA
IL41	HOOPESTON
IL42	DANVILLE
IL43	QUINCY
IL44	PITTSFIELD
IL45	BEARDSTOWN
IL45	MEREDOSIA
IL46	JACKSONVILLE
IL47	AUBURN
IL47	CHATHAM
IL47	SPRINGFIELD
IL48	KINCAID
IL49	BLUE MOUND
IL49	DECATUR
IL49	MT ZION
IL50	HAMMOND
IL50	TUSCOLA
IL51	CHARLESTON
IL51	MATTOON
IL52	MARSHALL
IL52	PARIS
IL53	CARLINVILLE
IL53	LITCHFIELD
IL53	WILSONVILLE
IL54	COFFEEN
IL54	GREENVILLE
IL54	HILLSBORO
IL55	VANDALIA
IL56	EFFINGHAM
IL57	GREENUP
IL58	HUTSONVILLE
IL58	ROBINSON
IL59	BRIGHTON
IL59	EAST ALTON
IL59	EDWARDSVILLE
IL59	GODFREY

Exhibit B-4
(continued)

IL59	HARTFORD
IL59	ROXANA
IL59	WOOD RIVER
IL60	ALTON
IL60	BELLEVILLE
IL60	EAST CARONDELE
IL60	EAST CARONDELET
IL60	EAST ST LOUIS
IL60	GRANITE CITY
IL60	MADISON
IL60	SAUGET
IL61	HIGHLAND
IL61	SCOTT AFB
IL62	CENTRALIA
IL62	HOFFMAN
IL62	SALEM
IL63	FLORA
IL64	OLNEY
IL65	LAWRENCEVILLE
IL66	FAIRFIELD
IL67	MT CARMEL
IL68	WATERLOO
IL69	SPARTA
IL69	STEELVILLE
IL70	BENTON
IL70	MOUNT VERNON
IL70	MT VERNON
IL70	NORTH CITY
IL71	CARBONDALE
IL71	MURPHYSBORO
IL72	HERRIN
IL72	MARION
IL73	ANNA
IL73	WOLF LAKE
IL74	METROPOLIS
IL75	SHELBYVILLE
IL99	UNSPECIFIED

Exhibit B-5

ILLINOIS CLUSTERS

Record#	CLUSTER	LAT	LON	SW_ENVIR	GW_ENVIR	RING1_POP	RING2_POP	RING3_POP	RING4_POP	DRINK_GW	DRINK_SW	DRINK_LAKE
1	IL01	42.48	87.83	4	9	4420	20011	58658	155634	0.40	0.00	0.60
2	IL02	42.44	88.24	4	9	523	3336	42650	102276	1.00	0.00	0.00
3	IL03	42.20	87.95	4	9	633	25107	168258	477723	0.26	0.00	0.74
4	IL04	42.17	88.30	4	9	3159	16455	72969	163460	1.00	0.00	0.00
5	IL05	41.90	87.73	4	2	22765	483522	1305179	1633544	0.12	0.00	0.88
6	IL06	41.88	88.06	4	2	6317	86009	252118	692175	0.96	0.04	0.00
7	IL07	41.49	87.56	4	2	4936	22365	184566	544812	0.87	0.13	0.00
8	IL08	41.53	88.09	6	2	6782	84429	63427	79837	1.00	0.00	0.00
9	IL09	42.25	88.73	4	9	524	0	21685	24252	1.00	0.00	0.00
10	IL10	42.34	89.02	5	9	1530	34457	113814	126890	1.00	0.00	0.00
11	IL11	42.28	89.60	5	9	1036	21879	9248	12884	1.00	0.00	0.00
12	IL12	42.35	90.01	4	9	1865	725	744	10866	1.00	0.00	0.00
13	IL13	42.42	90.43	6	9	2399	2378	1388	13344	1.00	0.00	0.00
14	IL14	42.09	90.14	6	9	3027	2220	2840	7081	1.00	0.00	0.00
15	IL15	41.50	90.51	6	2	7189	67045	173126	61112	0.14	0.86	0.00
16	IL16	41.67	89.94	6	1	2141	741	1927	14272	1.00	0.00	0.00
17	IL17	41.90	89.54	6	9	0	1155	23377	35308	1.00	0.00	0.00
18	IL18	42.01	89.33	6	9	2898	1833	6408	12820	1.00	0.00	0.00
19	IL19	41.93	88.76	4	9	7093	27664	14912	8513	1.00	0.00	0.00
20	IL20	41.64	88.45	5	1	1968	4335	15333	107915	1.00	0.00	0.00
21	IL21	41.50	89.02	6	1	0	659	6682	15665	1.00	0.00	0.00
22	IL22	41.36	88.44	6	1	1973	6899	5672	17328	1.00	0.00	0.00
23	IL23	41.25	87.84	5	9	4951	0	14134	71582	0.22	0.78	0.00
24	IL24	41.35	89.74	4	1	1130	0	2968	9544	1.00	0.00	0.00
25	IL25	41.33	89.20	6	6	3139	3368	29492	13971	1.00	0.00	0.00
26	IL26	41.12	88.83	4	1	6076	15035	3905	5574	0.06	0.94	0.00
27	IL27	41.00	88.52	4	1	1083	283	1006	20683	0.45	0.55	0.00
28	IL28	40.65	88.40	4	1	143	192	1529	9168	1.00	0.00	0.00
29	IL29	40.91	90.65	4	1	6211	5547	2232	5823	1.00	0.00	0.00
30	IL30	41.17	90.04	4	1	3151	328	1570	21963	1.00	0.00	0.00
31	IL31	41.08	89.63	6	1	0	391	1383	8082	1.00	0.00	0.00
32	IL32	40.80	89.20	4	6	2001	613	2651	17779	0.86	0.14	0.00
33	IL33	40.70	89.59	6	2	4470	79634	114046	91714	0.69	0.31	0.00
34	IL34	40.48	88.99	4	2	10550	66973	9534	11421	0.96	0.04	0.00
35	IL35	40.46	90.67	4	6	6205	10839	7254	10568	0.33	0.67	0.00
36	IL36	40.30	90.06	6	2	3715	1332	2228	6808	1.00	0.00	0.00
37	IL37	40.25	89.44	4	2	379	388	1851	26068	1.00	0.00	0.00
38	IL38	40.15	88.95	4	1	5144	4046	2629	8464	1.00	0.00	0.00
39	IL39	40.24	88.19	4	6	1242	1145	21377	110247	1.00	0.00	0.00
40	IL40	40.78	87.73	4	6	4670	873	3204	6873	1.00	0.00	0.00
41	IL41	40.47	87.67	4	6	4085	2566	2719	6257	1.00	0.00	0.00
42	IL42	40.13	87.62	4	6	5673	35347	20744	16949	0.07	0.93	0.00
43	IL43	39.93	91.39	6	2	7336	37759	9623	10805	0.20	0.80	0.00
44	IL44	39.60	90.81	6	2	1007	3645	1201	6132	0.48	0.52	0.00
45	IL45	40.02	90.43	6	2	6247	985	1601	7467	0.98	0.02	0.00
46	IL46	39.74	90.23	4	6	2617	21817	2031	5853	0.53	0.47	0.00
47	IL47	39.79	89.64	4	2	8265	82134	43855	22552	0.06	0.94	0.00
48	IL48	39.55	89.29	4	2	3705	7643	3751	9156	0.42	0.58	0.00
49	IL49	39.77	88.88	4	2	264	6923	44660	72823	0.56	0.44	0.00
50	IL50	39.80	88.28	4	6	3839	1338	1462	14738	1.00	0.00	0.00
51	IL51	39.48	88.38	4	1	4360	14929	3516	28229	0.00	1.00	0.00
52	IL52	39.11	87.66	4	1	705	733	1275	15501	0.37	0.63	0.00
53	IL53	39.12	89.81	4	2	3938	1013	5788	27117	0.01	0.99	0.00
54	IL54	39.04	89.46	4	2	0	256	3338	18321	0.13	0.87	0.00
55	IL55	38.96	89.10	4	2	4397	2239	2180	6247	0.00	1.00	0.00
56	IL56	39.12	88.54	4	6	3624	8729	5149	11413	0.13	0.87	0.00
57	IL57	39.16	88.15	4	1	161	632	2044	8852	0.75	0.25	0.00
58	IL58	39.01	87.74	4	2	3695	5654	1856	9862	1.00	0.00	0.00
59	IL59	38.86	90.08	6	1	3395	28376	44747	175069	0.32	0.68	0.00
60	IL60	38.57	90.19	6	1	2817	47490	356705	674823	0.38	0.62	0.00
61	IL61	38.53	89.70	4	1	2476	0	11105	34135	0.22	0.78	0.00
62	IL62	38.52	89.13	4	6	7018	13237	6743	12193	0.00	1.00	0.00
63	IL63	38.67	88.49	4	6	3165	3751	1043	7353	0.00	1.00	0.00
64	IL64	38.72	87.97	4	2	255	731	12068	6886	0.11	0.89	0.00
65	IL65	38.72	87.97	6	2	255	731	12068	6886	1.00	0.00	0.00
66	IL66	38.38	88.37	4	2	2349	3641	3845	4206	0.12	0.88	0.00
67	IL67	38.41	87.77	6	2	1350	8449	0	16353	0.57	0.43	0.00
68	IL68	38.33	90.15	6	1	2312	2613	6142	25039	0.17	0.83	0.00
69	IL69	38.01	89.66	4	1	2240	1700	2587	18580	0.54	0.46	0.00
70	IL70	38.08	88.86	4	1	321	1029	6324	14660	0.00	1.00	0.00
71	IL71	37.77	89.34	6	1	4707	6254	10529	35190	0.01	0.99	0.00
72	IL72	37.34	89.25	4	1	97	223	3958	14046	0.17	0.83	0.00
73	IL73	37.34	89.25	6	2	97	223	3958	14046	0.90	0.10	0.00
74	IL74	37.15	88.73	6	1	2926	4899	8967	50460	1.00	0.00	0.00
75	IL75	39.41	88.80	4	2	4358	909	2685	7803	1.00	0.00	0.00

Exhibit B-6

POPULATION BREAKDOWN

Adult men	38.1%
Adult women	41.3
Children (13 yrs. and younger)	20.6
	100.0%

Appendix C

DETAILS OF DATA SUMMARIES

Exhibit C-1

ILLINOIS GENERATION BY
RCRA WASTE CODE

WASTE CODE	TOTAL METRIC TONS
D000*	46.823
D001	43312.948
D002	749293.887
D003	8720.982
D004	43.818
D005	122.910
D006	5664.424
D007	15433.571
D008	31897.060
D009	833.340
D010	62.010
D011	7.449
D013	0.000
D014	0.000
D015	0.000
D016	56.201
D017	0.057
F001	6371.603
F002	3678.021
F003	7602.554
F004	422.113
F005	87535.706
F006	25408.377
F007	31219.769
F008	524.262
F009	1189.522
F010	0.400
F011	10.545
F012	163.718
F017	457.415
F019	69.462
K001	3085.447
K004	22.623
K023	7.788
K032	278077.211
K034	27.620
K035	2.080
K044	202.390
K046	14.048
K048	171919.130
K049	3107.416
K050	55.018
K051	31651.789
K052	412.312
K061	39948.435
K062	164850.311
K069	492.121
K071	0.000
K085	183.332
K086	868.003

*Non-hazardous waste

WASTE CODE	TOTAL METRIC TONS
K087	45.036
K093	165.382
K094	932.750
K100	0.000
K102	0.000
P001	14.700
P003	0.000
P004	0.000
P009	0.013
P011	0.000
P012	2.156
P014	0.000
P021	0.000
P022	0.024
P026	0.000
P028	0.000
P029	1.040
P030	65.080
P037	0.000
P039	0.182
P045	31.311
P051	84.477
P059	21611.077
P063	0.000
P064	0.000
P071	0.324
P075	0.381
P077	771.065
P082	0.000
P087	0.000
P089	0.026
P092	0.208
P094	75.059
P095	0.413
P098	0.117
P104	0.000
P105	0.160
P106	0.282
P110	0.000
P115	0.000
P119	0.000
P120	6.500
P121	0.007
P122	0.000
U001	0.681
U002	82.808
U003	0.081
U004	0.000
U006	0.000
U007	0.000

Exhibit C-1

(Continued)

WASTE CODE	TOTAL METRIC TONS
U008	5.384
U009	1.012
U012	130.670
U017	0.000
U019	13.692
U021	0.000
U022	0.000
U028	37.077
U031	0.013
U032	0.535
U036	76.960
U037	4.060
U041	0.000
U044	3.380
U045	0.000
U048	0.000
U051	4451.753
U052	0.004
U053	0.003
U055	0.000
U056	18.952
U057	0.387
U061	0.262
U067	2.711
U069	1.720
U070	0.296
U071	25.800
U075	0.000
U077	0.554
U078	0.000
U080	7.606
U081	0.000
U082	0.000
U099	0.000
U103	15.021
U107	0.222
U108	0.793
U112	12.890
U113	0.000
U116	0.050
U117	0.036
U121	0.000
U122	14.277
U123	0.003
U125	0.000
U129	10343.131
U130	1145.607
U131	0.004
U133	0.208
U134	0.000

Exhibit C-1

(Continued)

WASTE CODE	TOTAL METRIC TONS
U135	0.208
U140	108.376
U144	0.000
U145	0.000
U147	0.796
U151	3.796
U154	36.198
U155	0.008
U158	0.744
U159	95.684
U160	0.000
U161	0.000
U162	93.300
U164	0.000
U165	3.372
U169	0.018
U170	0.000
U173	2.740
U177	0.423
U181	0.290
U187	0.000
U188	299.618
U190	219.291
U191	0.073
U196	2.299
U201	0.005
U204	0.225
U209	0.000
U210	3.983
U211	2.702
U213	1.564
U216	0.000
U219	1.620
U220	47.584
U223	3.883
U225	0.000
U226	127.892
U227	0.041
U228	39.037
U230	0.000
U237	0.000
U238	13.782
U239	18.549
U240	14.940
U242	410.099
U244	2.283
U246	0.013
U247	0.350
COMB	388527.430

Exhibit C-1

(Continued)

WASTE CODE	TOTAL METRIC TONS
*** Total ***	2145365.650

ILLINOIS GENERATION BY
GENERATOR SIC CODE

(2 Digit)

SIC CODE	TOTAL METRIC TONS
0*	19117.941
3*	18.082
4*	48.180
12	392.891
13	461.246
15	32.321
16	1.068
17	2367.606
19	0.592
20	81.674
22	61.560
23	74.919
24	26.475
25	891.930
26	4006.789
27	5714.114
28	1110792.911
29	204075.120
30	400.743
31	14.580
32	178.618
33	124490.676
34	89610.765
35	11536.457
36	8496.754
37	11527.877
38	372.350
39	458.105
40	238.953
42	48289.727
45	14.318
46	87.927
47	60.379
48	60.614
49	490801.610
50	6347.311
51	221.344
52	10.296
53	7.771
55	237.157
58	79.267
60	1251.527
63	1.382
67	0.750
72	41.499
73	460.533
75	1.341
76	312.491
79	1062.400

*Miscoded SIC codes.

Exhibit C-2

(Continued)

SIC CODE	TOTAL METRIC TONS
80	67.680
82	60.020
84	0.381
86	0.198
92	1.133
95	337.329
96	0.045
97	57.955
*** Total ***	2145365.682

Exhibit C-3

LANDFILL SITES

TSDF ID	TSDF NAME	CITY	CLUSTER	AMOUNT TREATED (KG OFFSITE)	AMOUNT TREATED (KG ONSITE)
ILD000667139	BRIGHTON LANDFILL #2	BRIGHTON	IL59	8020315.4	0.0
ILD000805812	PEORIA DISPOSAL CO-#1	PEORIA	IL33	21037089.1	0.0
ILD005263157	NORTHWESTERN STEEL & WIRE #2	STERLING	IL17	0.0	5762450.5
ILD010284248	CID PROCESSING #1	CALUMET CITY	IL07	79418645.4	53682362.8
ILD980700728	CECOS INTERNATIONAL	ZION	IL01	39912229.9	0.0
*** Total ***				148388279.8	59444813.3

Exhibit C-4

SURFACE IMPOUNDMENT SITES

TSDF ID	TSDF NAME	CITY	CLUSTER	AMOUNT TREATED (KG ONSITE)
ILD000806075	ILLINOIS POWER COMPANY	CLINTON	IL38	14979744.0
ILD000819946	KOPPERS COMPANY INC	CARBONDALE	IL71	1994254.5
ILD005072517	AMERICAN NICKELOID COMPANY	PERU	IL25	1886363.5
ILD005109525	GILBERT & BENNETT MFG CO	BLUE ISLAND	IL07	56361.3
ILD005141726	PETERSON-PURITAN INC	DANVILLE	IL42	15329.7
ILD005476882	MARATHON OIL CO	ROBINSON	IL58	243268.4
ILD006009690	ELECTROMOTIVE-DIV OF GMC	MCCOOK	IL05	931036.4
ILD006271696	OLIN CORPORATION-MAIN PLANT	EAST ALTON	IL59	31677.2
ILD006278170	ALLIED CHEMICAL CORP	METROPOLIS	IL74	68363632.0
ILD020367561	KERR-MCGEE CHEMICAL CORP	MADISON	IL60	613636.4
ILD041539230	PIERCE CHEMICAL COMPANY	ROCKFORD	IL10	12.0
ILD042659672	NATIONAL MARINE SERVICE INC	HARTFORD	IL59	7587.5
ILD042671248	TEXACO INC	LAWRENCEVILLE	IL65	2147899.0
ILD047028881	COM ED-KINCAID STATION	KINCAID	IL48	4149999.5
ILD048296180	NORCHEM INC	MORRIS	IL22	1986954.2
ILD062338694	GENERAL ELECTRIC COMPANY	MORRIS	IL22	1961.6
ILD080012305	SHELL OIL COMPANY-REFINERY	ROXANA	IL59	36720455.9
ILD980503106	AMOCO PETROLEUM ADDITIVES CO	WOOD RIVER	IL59	154545440.0
ILD980700967	AMOCO PETROLEUM ADDITIVES CO	WOOD RIVER	IL59	6508636.9
ILT180012544	UNR-ROHN INC	PEORIA	IL33	1963636.5
*** Total ***				
				297147886.5

Exhibit C-5

UNDERGROUND INJECTION
TREATMENT SITES

GENERATOR ID	GENERATOR NAME	CITY	SIC	CLUSTER	AMOUNT TREATED (KG ONSITE)
ILD042075333	CABOT CORPORATION	TUSCOLA	2819	IL50	269199262.0
ILD000781591	LTV STEEL COMPANY INC-WELL	HENNEPIN	4210	IL25	34728815.9
ILD005463344	ALLIED CHEMICAL CORP	DANVILLE	4953	IL42	62282414.9
ILD000814673	VELSICOL	MARSHALL	2879	IL52	277958636.0
*** Total ***					644169128.8

Exhibit C-6

WASTE PILE SITES

GENERATOR ID	GENERATOR NAME	CITY	SIC	CLUSTER	AMOUNT TREATED (KG ONSITE)
ILD056623598	LTV STEEL COMPANY INC	CHICAGO	3400	IL05	9087272.0
ILD005476882	MARATHON OIL CO	ROBINSON	2851	IL58	279710.5
ILD000819946	KOPPERS COMPANY INC	CARBONDALE	0	IL71	3912273.0
ILD980996862	BIRMINGHAM BOLT COMPANY INC	BOURBONNAIS	4953	IL23	823635.4
ILD006280606	LACLEDE STEEL CO	ALTON	4953	IL60	10527274.0
ILD006278360	REILLY TAR & CHEMICAL CORP	GRANITE CITY	4953	IL60	104544.0
ILD000802702	MONSANTO CO-W G KRUMMRICH PLT	SAUGET	4955	IL60	531670.0
ILD005141551	GENERAL MOTORS CENTRAL FOUNDRY	DANVILLE	4953	IL42	1555664.6
*** Total ***					26822043.5

Exhibit C-7

LAND TREATMENT SITES

GENERATOR ID	GENERATOR NAME	CITY	SIC	CLUSTER	AMOUNT TREATED (KG ONSITE)
ILD000814780	GENERAL INSTRUMENT CORP	CHICAGO	4953	IL05	720.0
ILD005476882	MARATHON OIL CO	ROBINSON	2851	IL58	6992836.5
ILD042671248	TEXACO INC	LAWRENCEVILLE	4953	IL65	3434454.5
*** Total ***					10428011.0

Exhibit C-8

ILLINOIS INCINERATED WASTE
BY RCRA WASTE CODE

WASTE CODE	TOTAL METRIC TONS
D001	7787.825
D002	250.116
D003	1845.763
D004	1336.496
D005	1.804
D006	0.109
D007	62.692
D008	205.502
D012	0.188
D013	20.822
D014	0.350
F001	93.349
F002	45.654
F003	127.943
F005	19.766
F006	88.878
F011	1.600
K032	4.725
K035	1.230
K049	691.167
K050	25.195
K052	1.797
K073	37.944
K085	29.641
P030	0.273
P045	31.311
P081	29.657
U003	2.046
U009	0.070
U019	8.271
U028	13.635
U036	3.368
U061	3.205
U067	2.710
U070	0.045
U117	0.036
U122	3.345
U129	0.227
U154	4.050
U159	48.886
U169	0.200
U188	2.855
U190	0.102
U220	1.169
U223	9.806
U230	3.520
U239	2.014
U246	0.011
U247	0.350
COMB	3186.413

WASTE CODE	TOTAL METRIC TONS
*** Total ***	16038.131

Appendix D

ILLINOIS REGULATORY SYSTEM DESCRIPTION

G. Other Information

The data from the annual generator and facility reports is too extensive for all detailed reports to be included here. Readers may want to refer to two additional Agency reports: "Companies that Generate Hazardous Waste and Ship It Off-Site, 1985 Annual Report" and "Companies that Treat, Store, and Dispose of Hazardous Waste, 1985 Annual Report." These publications are available upon request. Address written requests to the attention of:

Bob Casteel
Division of Land Pollution Control
Illinois Environmental Protection Agency
2200 Churchill Road
Post Office Box 19276
Springfield, Illinois 62794-9276

Interpretation of the data from the annual reports is complicated by the many different ways in which wastes are managed by Illinois generators and facilities. A waste generator may send some of his waste off-site for recycling, send another type of waste for incineration, and yet another type for disposal. His decision will depend on the nature of the waste, the costs of management alternatives, and other factors. He may be classified as a small-quantity generator, in which case he is not subject to the reporting requirement.

TSDF reporting scenarios are similarly varied. An out-of-state generator shipping waste to an Illinois TSDF is not subject to the Illinois reporting requirement, yet the waste will be reported by the Illinois TSDF on their Facility Report. All waste from small quantity generators received by an Illinois TSDF will also be reported by the TSDF.

Source: IEPA/LPC/85-010

Figure 6 illustrates some of the complexity of the hazardous waste reporting process by showing five types of generators, four types of facilities, and the ways hazardous waste moves between them. The figure is complicated because it reflects the complexity of the reporting requirements. A careful reading of the following explanation will illustrate in more detail how the reporting system works and what the data really means.

Generator #1 is located outside Illinois. He does not complete a Generator Report for the State of Illinois. In our example, he has a listed waste that is sent to an Illinois recycler (TSDF #1) who treats the waste and returns the treated material to Generator #1. TSDF #1 would report the volume of waste treated on his Facility (TSDF) Report and the amount of residue created in the treatment process on a Generator Report as waste shipped to TSDF #4 in another state. Generator #1 has another hazardous waste that was sent to TSDF #2 for incineration. TSDF #2 being located in Illinois would report the quantity treated (incinerated) and then report the residue from the incineration process as being generated and shipped to TSDF #3 for land disposal or to TSDF #4 out-of-state. Generator #1 has a third waste stream that goes to TSDF #3 in Illinois for land disposal and is reported by that facility. Waste going from Generator #1 to TSDF #4 is not illustrated since both are located outside of Illinois and do not report.

Generator #2 is located in Illinois and completes a Generator Report listing all waste shipped to all four example TSDFs, including #4 that is located out-of-state.

Source: IEPA/LPC/85-010

A large volume of Generator #3's waste is treated, stored, or disposed on-site. To avoid double counting, these wastes are only reported on a Facility Report. In addition, Generator #3 has some smaller waste streams that are not amenable to on-site TSDF. These are shipped off-site to TSDFs #1 through #4 and a Generator Report is completed for these waste streams. Thus Generator #3 completes both Generator and Facility Reports.

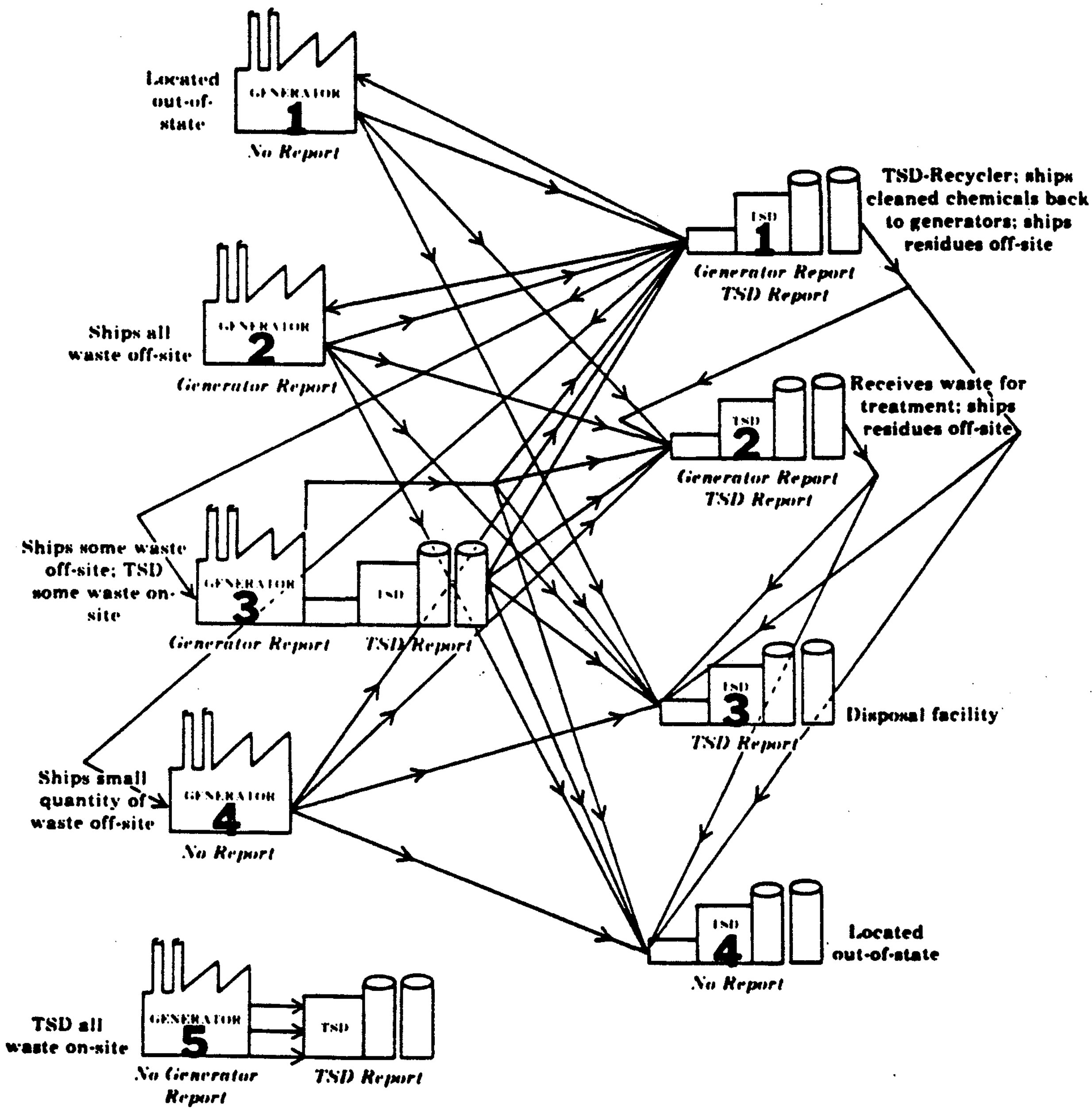
Generator #4 generates less than 1000 kg per month of RCRA hazardous waste and is exempt from the Annual Report requirement as a small quantity generator. While Generator #4 does not report, his waste is reported on Facility Reports by TSDFs #1 through #3.

Generator #5 sends none of his waste off-site. Generator #5 does not complete a Generator Report but does complete a Facility Report.

Source: IEPA/LPC/85-010

FIGURE 6

HAZARDOUS WASTE REPORTING SCENARIOS



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Source: IEPA/LPC/85-010

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Source: IEPA/LPC/85-010

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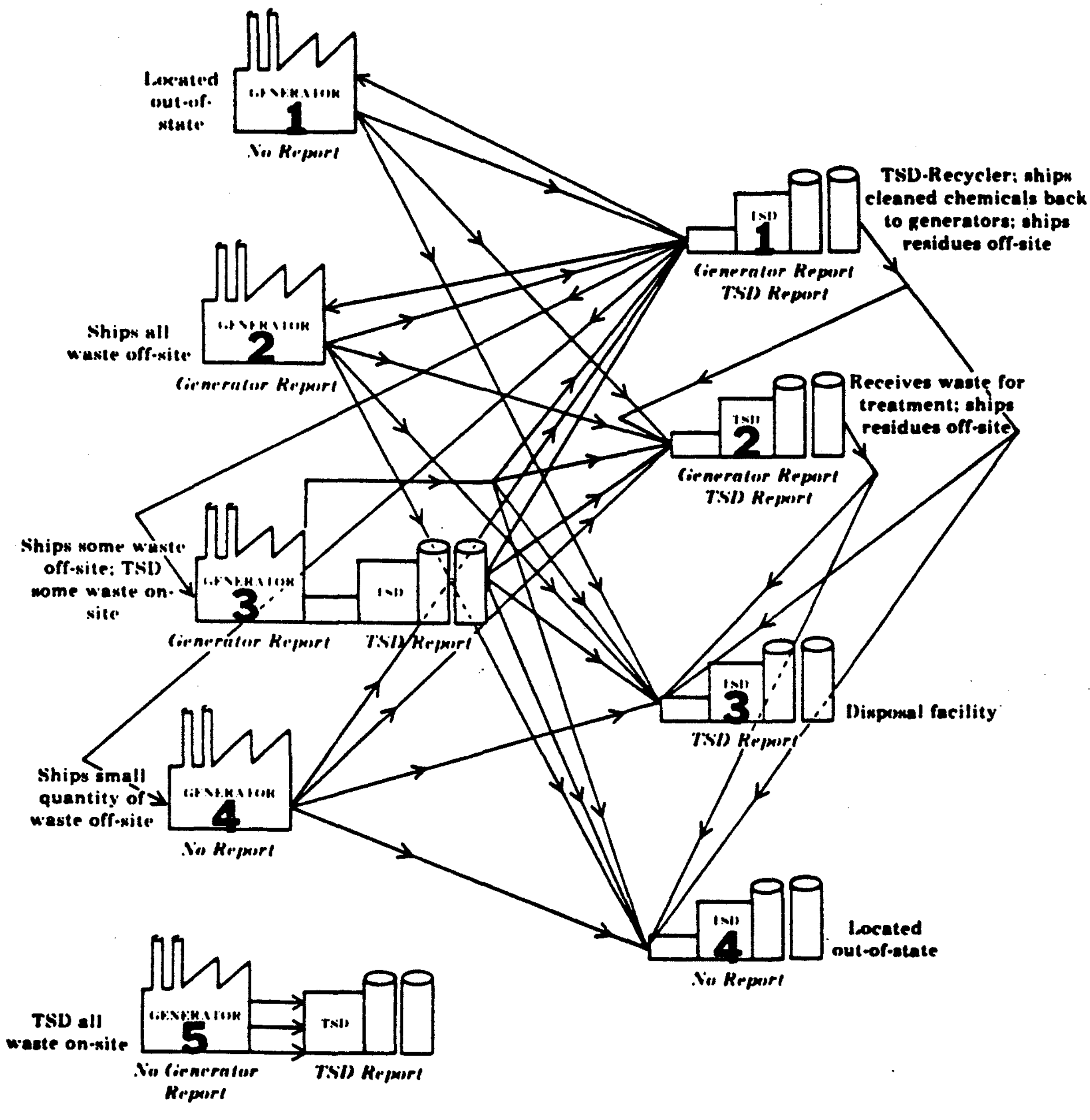
Generator #5 sends none of his waste off-site. Generator #5 does not complete a Generator Report but does complete a Facility Report.

FIGURE 6

HAZARDOUS WASTE REPORTING SCENARIOS



Source: IEPA/LPC/85-010